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PATENT APPLICATION

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CASE 21-1-3-12

TITLE Enhanced Frequency Hopping In A Wireless System

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

NEW APPLICATION UNDER 37 CFR § 1.53(b)

Enclosed are the following papers relating to the above-named application for patent:

Specification – 17 pages
6 Informal Sheets of drawing(s)
Information Disclosure Statement with two (2) references attached.

CLAIMS AS FILED				
	NO. FILED	NO. EXTRA	RATE	CALCULATIONS
Total Claims	27 - 20 =	7	x $18 =	$126
Independent Claims	13 - 3 =	10	x $80 =	$800
Multiple Dependent Claims, if applicable			+ $270 =	$0
Basic Fee				$710
			TOTAL FEE	$1636

Please file the application and charge **Lucent Technologies Deposit Account No. 12-2325** the amount of $1636, to cover the filing fee. Duplicate copies of this letter are enclosed. In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit **Deposit Account No. 12-2325** as required to correct the error.

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"Express Mail" mailing label number EK218523860US
Date of Deposit MAY 7, 2001
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Please address all correspondence to **Docket Administrator (Room 3C-512), Lucent Technologies Inc., 600 Mountain Avenue, P.O. Box 636, Murray Hill, New Jersey 07974-0636**. However, telephone calls should be made to me at 732-949-1708.

Respectfully,

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Date: May 7, 2001

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ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM

FIELD OF THE INVENTION

This invention relates generally to communications and, more particularly, to wireless communications systems.

BACKGROUND OF THE INVENTION

Advances in wireless technologies have propelled a migration in features and services provided to the end user. Network operators may however need to support multiple and perhaps migratory technologies with limited spectrum. Therefore, radio resource management techniques that improve spectral efficiency and/or system capacity are always of interest to network operators.

Higher spectral efficiency and/or voice capacity can be achieved in the Global System for Mobile Communication (GSM) Enhanced Data rates for Global Evolution (EDGE) Radio Access Network (GERAN) through tight frequency reuse (e.g., 1/3 or 1/1 reuse). Current GSM deployments employ techniques such as frequency hopping in order to combat the effects of fading and interference. The performance improvement achieved through frequency hopping for voice users at the link and system level directly translates into higher capacity.

On a GSM full rate traffic channel, 20 ms (milli-second) speech frames are convolutionally encoded and diagonally interleaved over a sequence of 8 bursts in a time slot. In the case of a half rate channel, speech is coded and diagonally interleaved over a sequence of 4 alternate bursts in a time slot. Frequency hopping is carried out burst by burst in order to mitigate the effects of slow fading and interference. It provides the following benefits: fading diversity, interferer diversity, and interference averaging.

In practical systems, the frequency hopping is typically non-ideal and the benefits of fading and interferer diversity are not fully realized. With respect to frequency hopping techniques, GSM specifies cyclic frequency hopping and pseudo-random frequency hopping (e.g., see 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)"). If the

number of frequencies is sufficient, then cyclic hopping provides full fading diversity. (As referred to herein, full fading diversity is where every burst within the interleaving depth of a speech frame experiences an independent fading state. This is possible only if the number of frequencies is greater than the number of bursts over which a speech frame is interleaved and the frequencies are sufficiently separated from each other.) However, cyclic hopping does not provide the benefits of interferer diversity and interference averaging. The pseudo-random frequency hopping algorithm specified in GSM provides interferer diversity and achieves long-term interference averaging but does not guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth of a speech frame.

With respect to GSM pseudo-random frequency hopping, if a large amount of spectrum is allocated, then there are many frequencies over which users can hop and repeated frequencies over a short interval are not common. However, in limited spectrum scenarios where the number of frequencies are smaller than the number of bursts over the interleaving depth (40 ms in the speech case), frequency repetitions always occur. This is illustrated in FIG. 1 on a full rate traffic channel. For full-rate voice users, eight bursts are transmitted over pseudo-randomly generated frequencies (it is assumed for this example that there are eight frequencies to select from: f_0 to f_7). As can be observed from FIG. 1, coded speech frame 1 encounters frequency, f_4 , on 3 out of the 8 bursts that it is interleaved across. This implies that speech frame 1 experiences only 6 out of 8 possible independent fading states (assuming there is sufficient separation between each of the frequencies). Similarly, it can be observed for speech frame 2 that frequencies, f_2, f_4 and f_5 are repeated two times each on the 8 bursts over which coded speech frame 2 is interleaved. In this case, speech frame 2 experiences only 5 out of 8 possible independent fading states. In other words, the GSM pseudo-random frequency hopping algorithm does not maximize the number of unique frequencies (or independent fading states) in this case. This has consequences for low mobility users where the fading tends to be strongly correlated for time duration in excess of the interleaving depth of a speech frame. In this case, users may hop to the same frequency multiple times, experiencing similar channel fading conditions each time. With typical channel coding schemes employed for

speech traffic channels and control signaling channels, increased correlation within the interleaving depth can lead to degradation in error performance.

SUMMARY OF THE INVENTION

In accordance with the invention, a wireless endpoint transmits signals using frequency hopping over a time period T by selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies.

In an embodiment of the invention, a wireless endpoint employs frequency hopping for communicating signals in a wireless communications system. Over a time period T, the wireless endpoint performs pseudo-random selection of a frequency from a hopping set such that over at least a portion of the time period T the choice of frequencies to select from within the hopping set is constrained as a function of previously selected frequencies. In particular, prior selected frequencies are temporarily prohibited from being selected again from the hopping set. Thus, repetition of frequencies over the time period T is reduced.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 illustrates prior art frequency repetition in a GSM pseudo-random hopping sequence over an illustrative time period;

FIG. 2 shows an illustrative high-level block diagram of a wireless endpoint for use in accordance with the principles of the invention;

FIG. 3 illustrates constrained frequency hopping in a GSM pseudo-random hopping sequence over an illustrative time period, T;

FIG. 4 shows Table One, which lists the parameters used in determining a pseudo-random frequency index S;

FIG. 5 shows an illustrative flow chart embodying the principles of the invention; and

FIG. 6 shows Table Two, which illustrates an application of the inventive concept.

DETAILED DESCRIPTION

Other than the inventive concept, familiarity with GSM is assumed and is not described herein. For example, other than the inventive concept, a form of frequency hopping used in GSM is described in 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)." In addition, the inventive concept is implemented using conventional programming techniques, which as such, will not be described herein.

FIG. 2 shows a high-level block diagram of a representative wireless endpoint 200 for use in accordance with the principles of the invention. Other than the inventive concept, the elements shown in FIG. 2 are well known and will not be described in detail. Wireless endpoint 200 represents a stored-program-control-based processor architecture and includes processor 250, memory 260 (for storing program instructions and data (such as a set of hopping frequencies), as further described below) and communications interface(s) 265 for coupling to one or more wireless communication paths as represented by path 266 (e.g., 265 represents a wireless transmitter and a wireless receiver). In the context of this invention, e.g., processor 250 and memory 260 implement (among other functions not described herein) a constrained frequency hopping method for selecting frequencies for use in transmission of signals via communications interface 265. A detailed description of the reception and transmission of wireless signals is not necessary for the inventive concept and, as such, is not described herein. Except as noted below, it is assumed that the wireless endpoint 200 is a part of a GSM system (not shown) and is in communication with another wireless endpoint (not shown). Wireless endpoint 200 is representative of any wireless device, e.g., a base station, mobile station, user terminal, etc.

In accordance with the invention, hopping frequency sequences are constrained in order to reduce, or minimize, repeated frequencies over a time period *T*. Consider a class of hopping sequences for which constraints are imposed to minimize repeated frequencies. For example, if the total number of frequencies, *N*, in a hopping set is equal to 4, the hopping sequence is constrained to prevent any repeats within a set of four bursts. Thus across two consecutive sets of four bursts, no frequency would be repeated

three or more times. A similar case can be made for $N = 8$. In this case, a constrained hopping sequence prevents the repetition of any frequency over 8 consecutive bursts (i.e., it guarantees 8 independent fading states). Hence, the maximum frequency repeat across an 8-tuple would be 1. This is shown in FIG. 3 for an illustrative speech frame 1, which illustrates constrained frequency hopping on a full rate traffic channel. It should be noted that although the negative effects of frequency repetitions decrease for GSM hopping sets with larger values of N, e.g., $N = 12$, the inventive concept still provides improvement.

In accordance with the invention, a hopping state, $\boldsymbol{H}$, is defined to be:

$$\boldsymbol{H} = \{H_0, H_1, \ldots, H_{F-1}, H_F, \ldots, H_{N-1}\}, \quad (1)$$

which is a vector of length N, where N is the total number of frequencies available to hop over, and F is $\leq N$ and is the number of frequencies in $\boldsymbol{H}$ over which the wireless endpoint is constrained to hop. $\boldsymbol{H}$ can also be defined as $\boldsymbol{H} = \boldsymbol{A} \cup \boldsymbol{B}$, where

$$\boldsymbol{A} = \{H_0, H_1, \ldots, H_{F-1}\}, \quad (2)$$

and is the set of F frequencies over which a wireless endpoint is currently allowed to hop and

$$\boldsymbol{B} = \{H_F, \ldots, H_{N-1}\} \quad (3)$$

and is the set of $(N - F)$ frequencies over which a wireless endpoint is not currently allowed to hop. In other words, $\boldsymbol{H}$ can be viewed as being divided into a set of allowable frequencies (**A**) and a set of prohibited frequencies (**B**). Let the range of F be defined by F_{min} and F_{max}, where $0 \leq F_{min} < F_{max} \leq N$.

For each hop (hops occur every 4.615 ms frame in the case of GSM), the transmitter and receiver (of corresponding wireless endpoints as represented by wireless endpoint 200 of FIG. 2) first use the following procedure in order to determine a pseudo-random frequency index, S (also referred to herein as a hopping index sequence value). Steps (4) through (8), below, are found in section 6.2.3 of the above-mentioned standard, 3GPP TS 45.002. Values for M (where $0 \leq M \leq 152$) and S (where $0 \leq S \leq N - 1$) are computed as follows:

$$M = T2 + RNTABLE\,((HSN \text{ xor } T1R) + T3); \quad (4)$$

$$M' = M \text{ modulo } (2 \text{ ^ } NBIN); \quad (5)$$

$$T' = T3 \text{ modulo } (2 \text{ ^ } NBIN); \quad (6)$$

if $M' < N$, *then* (7)

$S = M'$; (8)

else,

$S = (M' + T)$ *modulo* N; (9)

where the parameters used above are defined in Table One, which is shown in FIG. 4 (additional information on the parameters shown in Table One are found in the above-mentioned standard - 3GPP TS 45.002).

Normally, S is used to select one of the frequencies from **H**. However, and in accordance with the invention, this pseudo-random frequency index, S, is now used to select one of the allowable frequencies in $\boldsymbol{A}$. Note, that the pseudo-random frequency index S corresponds to the Mobile Allocation Index (MAI) that is generated by the GSM hopping algorithm for non-zero HSN (Hopping Sequence Number) and MAIO = 0, where MAI0 is the Mobile Allocation Index Offset. (In the generation of the pseudo-random frequency index, S, as described below for the inventive concept, MAIO=0 is employed for all users in a sector to ensure that users within a sector choose identical indices of $\boldsymbol{H}$. This guarantees that the hopping states are identical between all users within a sector. In GSM, each user in a sector is assigned a unique MAIO. This ensures that the frequency hopping sequences between users in the same sector are orthogonal. This concept still applies when using the inventive concept described below (e.g., see equation (11), below) as modulo addition of the MAIO guarantees no intra-sector collisions.) Now, let the sequence of pseudo-random frequency indices generated by the above-described algorithm be $\boldsymbol{S} = \{S_0, S_1, S_2, \ldots\}$. Note that $S_i \in \{0, 1, .., N-1\}$ can be larger than the number of allowable frequencies F. Therefore, in this constrained hopping algorithm, a wireless endpoint hops to:

Hopping Frequency = $(H_{S'} + \text{MAIO})$ modulo N where (10)

$S' = (S_i)$ modulo F. (11)

In other words, and in accordance with the invention, S' is restricted to the allowable set, **A**.

Turning now to FIG. 5, an illustrative flow chart is shown for updating the hopping state for a constrained frequency hopping method in accordance with the

principles of the invention. In steps 505, 510 and 515, the value of the currently hopped frequency, H_R, is swapped (via the variable c) with H_{F-1}, the last allowable frequency in **A**. Thus, the currently hopped frequency becomes the last element in the set **A**, at position F - 1. In the step 520, the size of **A** is reduced by decrementing F by one so that the set of frequencies over which the user can hop for the next burst is reduced (thus, excluding the currently hopped frequency, which is now effectively inserted into **B**). In step 525, if F reaches a pre-determined minimum value, F_{min}, (e.g., 0), F is reset to F_{max} and $\boldsymbol{H}$ is cyclically shifted to the right by (F_{max} - F_{min}) *modulo* N, and **A** is set equal to the first F_{max} elements of **H** (while **B** = **H** - **A** (which in some instances my be the null set)). In this way, the oldest candidates in $\boldsymbol{H}$ can be considered once again.

Consider an example with the following parameters:

$N = 8$ frequencies;

$F_{min} = 0$, $F_{max} = 4$;

Initial hopping state $\boldsymbol{H} = \{1\ 3\ 4\ 6\ 2\ 0\ 5\ 7\}$ (obviously, each number in **H** corresponds to an *a priori* assigned frequency); and

Initial value of $F = 4$.

Table Two, shown in FIG. 6, illustrates the constrained frequency hopping method when the GSM hopping index sequence, $\boldsymbol{S}$, is illustratively equal to {1 5 2 4 1...} for the first 5 bursts (burst number 0 through burst number 4). As can be observed from Table Two, the first column shows the burst number; the second column shows the associated value of the hopping index sequence for that burst number (taken from S = {1 5 2 4 1 ... }); the third column illustrates the allowable frequency set **A**; the fourth column shows the computed hop frequency in accordance with equations (10) and (11), above; the fifth column shows the updating of **H** (or equivalently **A** (and **B** for that matter)) using the method shown in FIG. 5; and the sixth column illustrates the value of F.

As noted above, and shown in the first row of Table Two, the initial set of hopping frequencies is **H** = {1 3 4 6 2 0 5 7} and $F = 4$. As such, for the first burst number of 0, **A** is effectively set equal to the first four hopping frequencies of **H**, as shown in row 2 of Table Two (and the remaining frequencies of **H** are a part of **B**). The

hop frequency is computed in accordance with equation (11), above, with the result shown in row 2 of Table Two, i.e., $H_1 = 3$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {1 6 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *1* is exchanged with the frequency value at index position (F - *1*). In this example, 3 is exchanged with 6 at the 1st and 3rd positions (recalling that the position index begins at 0). Finally, F is adjusted to 3, as shown in the final column entry for row 2 of Table Two.

As a result, since F is now equal to 3, for the next burst number of 1, the next hop frequency is now restricted to 1, 6, or 4 since the size of **A** has been reduced as shown in row 3 of Table 2. (Alternatively, the allowed frequency selections from **H** have been constrained to the first three frequencies.) The hop frequency is computed in accordance with equation (11), above, with the result shown in row 3 of Table Two, i.e., $H_2 = 4$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {1 6 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *2* is exchanged with the frequency value at index position (F - *1*). In this example though the positions are the same since the selected index position and the value of F are the same, i.e., 3. Therefore, the ordering of the frequencies in **H** does not change. Finally, F is adjusted to 2, as shown in the final column entry for row 3 of Table Two.

For the next burst number of 2, the next hop frequency is now restricted to 1 and 6 since the size of **A** has been reduced as shown in row 4 of Table 2 (since F now equals 2). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 4 of Table Two, i.e., $H_0 = 1$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *0* is exchanged with the frequency value at index position (F - *1*). In this example, 1 is exchanged with 6 at the 0th and 1st positions. Finally, F is adjusted to 1, as shown in the final column entry for row 4 of Table Two.

For the next burst number of 3, the next hop frequency is now restricted to 6 since the size of **A** has been reduced as shown in row 5 of Table 2 (since F now equals 1). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 5 of Table Two, i.e., $H_0 = 6$. **H** is now adjusted as shown in the flow chart

of FIG. 5, i.e., **H** = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *0* is exchanged with the frequency value at index position (F - *1*). In this example though the positions are the same since the selected index position and the value of F are the same, i.e., 0. As such, the ordering of the frequencies in **H** does not change. Finally, F is adjusted to 0, as shown in the final column entry for row 5 of Table Two. However, this update to F indicates that the minimum value is reached and hence, ***H*** is cyclically shifted by $(F_{max} - F_{min}) \bmod N = 4$ and F is reset to $F_{max} = 4$. This is shown by the additional entries in row 5 of columns 5 and 6 of Table Two, where now **H** = {2 0 5 7 6 1 4 3} and $F = 4$. Consequently, for the next burst number of 4, the size of **A** has been increased as shown in row 6 of Table 2 (since F now equals 4) and **A** = {2 0 5 7}. As a result of this constrained frequency hopping method, the hop sequence for the first 5 burst numbers is: 3, 4, 1, 6, (of course assuming that the MAIO associated with this user equals 0, else refer to equation (11)).

This algorithm is stated in a general way to allow flexibility in the actual implementation. Although the proposed change ultimately alters the hopping sequence, this algorithm uses the existing GSM hopping framework thus allowing legacy mobiles to be easily supported. In addition, the similarity to the current GSM hopping algorithm allows this feature to be turned off for cases such as large spectrum deployments where little to no gains do not warrant the additional complexity. In such cases, the regular GSM hopping algorithm can be employed.

Note, it is recommended that wireless endpoints run the proposed algorithm at all times, even during silence, in order to maintain the hopping state. Maintaining hopping states is needed to ensure that there are no intra-sector collisions.

Since the algorithm considers consecutive bursts spanning multiple frames, the algorithm easily applies to full rate voice (diagonally interleaved) and data (block interleaved) services. The algorithm also applies to half rate voice if $N \geq 8$.

The following should be noted with respect to protocol aspects. When a user enters the system (e.g. at the start of a voice call), the wireless endpoint must know the hopping state, ***H***, the number of currently allowable frequencies, F, and the range of F defined by $Fmin$ and $Fmax$ where $0 \leq Fmin < Fmax \leq F$. $Fmin$ and Fmax are assumed to

be provided during call setup. The network can provide $\boldsymbol{H}$ and F to a wireless endpoint (e.g., a user terminal) in any number of ways, such as:

1) These parameters can be provided during call setup signaling from another wireless endpoint along with an associated timestamp by suitable modification of messages used in existing call setup protocols. Since the algorithm to reconstruct the time evolution of $\boldsymbol{H}$ and F are known, either wireless endpoint can then determine the state information at the current time (effectively providing information on **A**, etc.); or

2) Alternatively, state information can be autonomously derived at a wireless endpoint by refreshing the state information at pre-determined time instants. For example, the state can be refreshed (i.e., $\boldsymbol{H} = \{ H_0, H_1, \ldots, H_{N-1} \}, F = Fmax)$ at pre-determined time instants. The wireless endpoint can then reconstruct the time evolution of $\boldsymbol{H}$ and F from the previous refresh instant to the current time.

As described above, and in accordance with the invention, a constrained hopping sequence has been described for reducing the rate at which frequencies are repeated (or alternatively, maximizes the number of independent fading states). The use of constrained frequency hopping allows GSM pseudo-random frequency hopping to achieve full fading diversity under spectrum constraints within the interleaving depth of a speech frame. As such, the constrained hopping algorithm maximizes the number of unique frequencies that occur over the interleaving depth of a speech frame. This permits an improvement in fading diversity performance with negligible impact on interferer diversity and interference averaging capability of the existing GSM pseudo-random hopping algorithm.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope. For example, although illustrated in the context of pseudo-random frequency selection, other selection methods may be used. Also, although shown as a separate elements, any or all of the elements of FIG. 1 (e.g.,

260) may be implemented in a stored-program-controlled processor.

WHAT IS CLAIMED:

1. A method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period T, by

selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies.

2. The method of claim 1 wherein frequency selection is done pseudo-randomly.

3. A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies; and

selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T.

4. The method of claim 3 wherein the selecting step selects the frequency pseudo-randomly.

5. A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of F frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

reducing the size of the hopping set over a portion of the time period T by at least one frequency.

6. A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

selecting frequencies from the hopping set over the time period T such that at least

one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

7. The method of claim 6 wherein the selecting step selects the frequency pseudo-randomly.

8. A method of frequency hopping for use in wireless equipment, where a hopping set is initialized to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T, the method comprising the steps of:

determining a hopping index value;

modifying the hopping index value by at least the modulo of a number F, where $F \leq N$;

selecting a hopping frequency from the hopping set as a function of the modified hopping index value;

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F;

reducing the value of F; and

returning to the determining step.

9. The method of claim 8 wherein when the value of F reaches a predefined minimum value, further including the step of shifting the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

10. A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T;

dividing the hopping set into an allowable frequency set and a prohibited frequency set;

selecting frequencies from the allowable frequency set; and

after at least one frequency selection, adjusting the membership in the allowable

frequency set and the prohibited frequency set.

11. The method of claim 10 wherein the selecting step selects the frequency pseudo-randomly.

12. The method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time.

13. The method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to the other wireless endpoint through explicit signaling.

14 The method of claim 10 wherein all *N* frequencies in the hopping set are assumed allowable at pre-determined time instants.

15. A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a prohibited frequency set; and

transmitting information associated with the division of the hopping set to another wireless endpoint.

16. The method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set.

17. A wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period *T*; and

a processor for selecting a frequency from a set of *N* frequencies such that over at least a portion of the time period *T*, the frequency selection is constrained to less than the *N* frequencies.

18. The wireless endpoint of claim 17 wherein frequency selection is done

pseudo-randomly.

19. A wireless endpoint comprising:

a memory for storing a set of hopping frequencies; and

a processor for selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T.

20. The wireless endpoint of claim 19 wherein the processor selects the frequency pseudo-randomly.

21. A wireless endpoint comprising:

a memory for storing a hopping set comprising F frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for reducing the size of the hopping set over a portion of the time period T by at least one frequency.

22. A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for selecting frequencies from the hopping set over the time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

23. The wireless endpoint of claim 22 wherein the at least one selected frequency is selected pseudo-randomly.

24. A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number F, where $F \leq N$, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d)

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of *F*, (e) reducing the value of *F*; and (f) returning to (a).

25. The wireless endpoint of claim 24 wherein when the value of *F* reaches a predefined minimum value, the processor further shifts the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for *F* and the minimum value, modulo *N*.

26. A wireless endpoint comprising:

a memory for storing a bopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set.

27. The wireless endpoint of claim 26 wherein the at least one selected frequency is selected pseudo-randomly.

ABSTRACT

A wireless endpoint employs frequency hopping for communicating signals in a wireless communications system. Over a time period T, the wireless endpoint performs pseudo-random selection of a frequency from a hopping set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies.

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FIG. 1

Prior Art

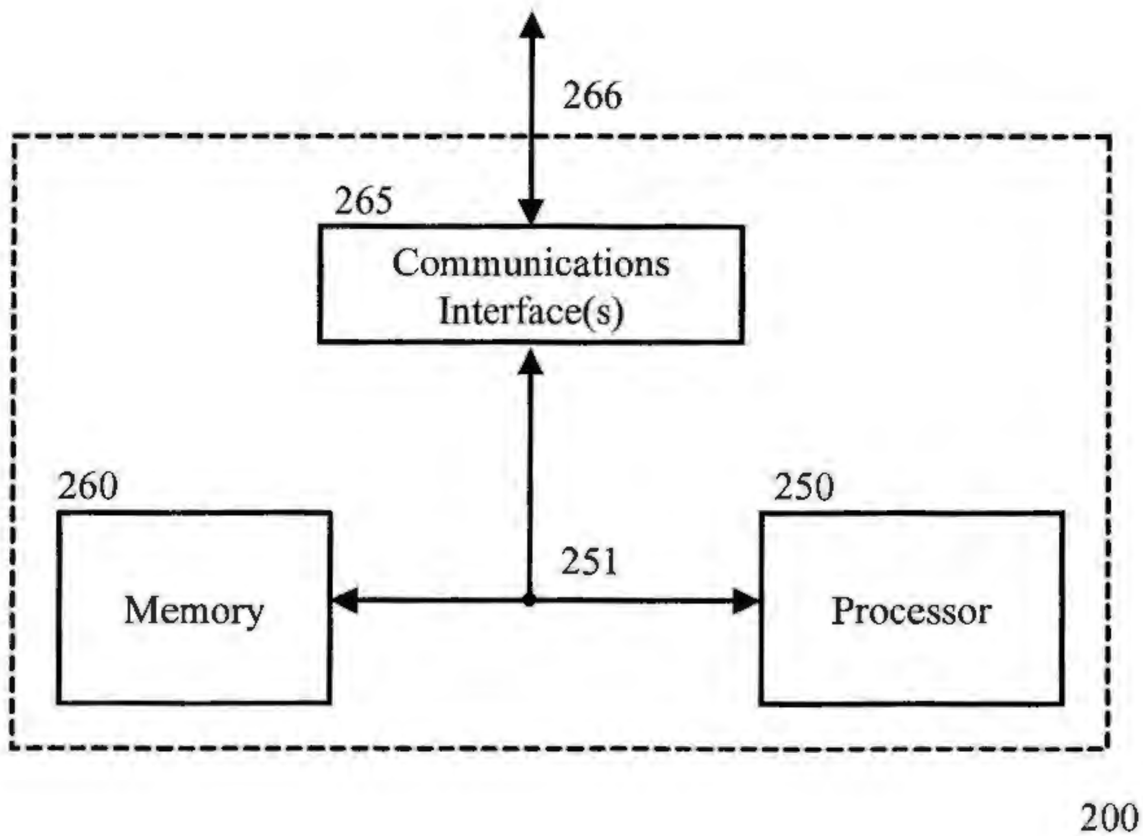
Speech frame 2

Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_4	f_4	f_5	f_6	f_2	f_2	f_3	f_5

Bursts

Speech frame 1

FIG. 2 Balachandran-Kang-Sanwal-Seymour 21-1-3-12



Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 3

Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_7	f_8	f_5	f_6	f_1	f_3	f_0	f_4

Bursts

Speech frame 1

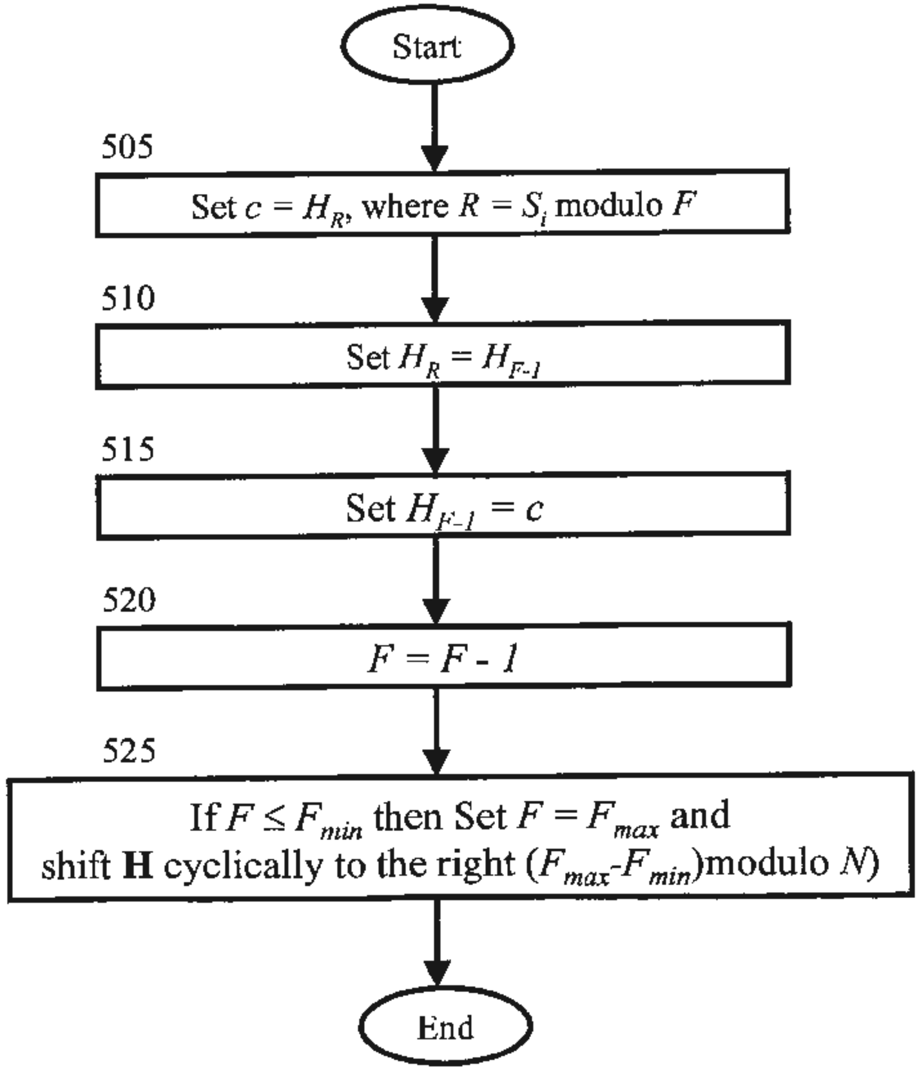
FIG. 4

Prior Art

Parameter	**Definition**	**Range**
TDMA Frame Number, *FN*	TDMA frame number	0 to (26 x 51 x 2048) - 1
Time parameter, *T1R*	[FN div (26 x 51)] modulo 64	0 to 63
Time parameter, *T2*	FN modulo 26	0 to 25
Time parameter, *T3*	FN modulo 51	0 to 50
Hopping Sequence Number (*HSN*)	Used along with other time parameters to generate a pseudo-random hopping sequence	0 to 63
NBIN	Number of bits required to represent *N*	
xor	Bit-wise exclusive or of 8 bit binary operands	

Table One

FIG. 5


Start
505
Set $c = H_R$, where $R = S_i$ modulo F
510
Set $H_R = H_{F-1}$
515
Set $H_{F-1} = c$
520
$F = F - 1$
525
If $F \leq F_{min}$ then Set $F = F_{max}$ and
shift **H** cyclically to the right (F_{max}-F_{min})modulo N)
End

Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 6

column 1

row 1

Burst Number	Hopping index	**A**	Compute Hop Frequency	**H**	*F*
--	--	--	--	$\boldsymbol{H} = \{1\ 3\ 4\ 6\ 2\ 0\ 5\ 7\}$	$F = 4$
0	1	$\boldsymbol{A} = \{1\ 3\ 4\ 6\}$	$H_{(1 \bmod 4)} = H_1 = 3$	$\boldsymbol{H} = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 3$
1	5	$\boldsymbol{A} = \{1\ 6\ 4\}$	$H_{(5 \bmod 3)} = H_2 = 4$	$\boldsymbol{H} = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 2$
2	2	$\boldsymbol{A} = \{1\ 6\}$	$H_{(2 \bmod 2)} = H_0 = 1$	$\boldsymbol{H} = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 1$
3	4	$\boldsymbol{A} = \{6\}$	$H_{(4 \bmod 1)} = H_0 = 6$	$\boldsymbol{H} = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$ $\boldsymbol{H} = \{2\ 0\ 5\ 7\ 6\ 1\ 4\ 3\}$	$F = 0,$ $F = 4$
4	1	$\boldsymbol{A} = \{2\ 0\ 5\ 7\}$	$H_{(1 \bmod 4)} = H_1 = 0$	$\boldsymbol{H} = \{2\ 7\ 5\ 0\ 6\ 1\ 4\ 3\}$	$F = 3$
• • •	• • •	• • •	• • •	• • •	• • •

Table Two

H

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/850,124	05/07/2001	Krishna Balachandran	21-1-3-12	1172

6980 7590 05/20/2004

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EXAMINER	
ZHENG, EVA Y	
ART UNIT	PAPER NUMBER
2634	6

DATE MAILED: 05/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/850,124	BALACHANDRAN ET AL.	
	Examiner	Art Unit	
	Eva Yi Zheng	2634	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _5/7/01_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-27_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-27_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _5_.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities: on page 7, line 9, phrase: "some instances my be" should be changed to --some instances may be--.

Appropriate correction is required.

Claim Objections

2. Claims 6, 10, 22, 24 and 26 are objected to because of the following informalities:

a) Regarding claims 6 and 10, on line 3, "initializing a hopping set of a size of N frequencies" should be changed to -- initializing a hopping set of a size of F frequencies--.

b) Regarding claims 22, 24 and 26, on line 2, "a memory for storing a hopping set comprising N frequencies" should be changed to -- a memory for storing a hopping set comprising F frequencies--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 9 recites the limitation "the step of shifting" on line 2. There is insufficient antecedent basis for this limitation in the claim. It should be changed to --a step of shifting--.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 1, 3, 5, 6, 8 -10, 12 -17, 19, 21, 22 and 24-26 are rejected under 35 U.S.C. 102(b) as being anticipated by Kung et al. (4,654, 859).

a) Regarding claim 1, Kung et al. disclose a method for use in wireless equipment, the method comprising the steps of

transmitting signals using frequency hopping over a time period T (Fig. 2 and 3),

by selecting a frequency (Col 4, L62-63) from a set of N frequencies (as shown in Fig. 2 and 3) such that over at least a portion of the time period T (as shown in Fig 2 and 3),

the frequency selection is constrained to less than the N frequencies (Col 4, L 42-60).

b) Regarding claim 3, Kung et al. disclose a method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies (32 in Fig.1); and

selecting frequencies (Col 4, L62-63) from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T (as shown in Fig. 2 and 3).

c) Regarding claim 5, Kung et al. disclose a method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of F frequencies (Col 2, L 45, imply as "30 frequencies"), the hopping set used to select therefrom hopping frequencies over a time period T (as shown in Fig. 2 and 3); and

reducing the size of the hopping set over a portion of the time period T by at least one frequency (Col 2, L40-41).

d) Regarding claim 6, Kung et al. disclose a method of frequency hopping for use in wireless equipment, the method comprising the steps of

initializing a hopping set to a size of N frequencies (Col 2, L 45, imply as "30 frequencies"), the hopping set used to select therefrom hopping frequencies over a time period T (as shown in Fig. 2 and 3); and

selecting frequencies (Col 4, L62-63) from the hopping set over the time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T (as shown in Fig 2 and 3).

e) Regarding claim 10, Kung et al. disclose a method of frequency hopping for use in wireless equipment, the method comprising the steps of

initializing a hopping set to a size of N frequencies (Col 2, L 45, imply as "30 frequencies"), the hopping set used to select therefrom hopping frequencies over a time period T (as shown in Fig. 2 and 3);

dividing the hopping set into an allowable frequency set and a prohibited frequency set (Col 2, L45-47, imply as "at least 10 Khz");

selecting frequencies from the allowable frequency set (Col 4, L62-63); and

after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set (Col 2, L 32-47).

f) Regarding claim 12, Kung et al. disclose the method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time (Col 2, L 32-47).

g) Regarding claim 13, Kung et al. disclose the method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to the other wireless endpoint through explicit signaling (Col 2, L 24-31).

h) Regarding claim 14, Kung et al. disclose the method of claim 10 wherein all N frequencies in the hopping set are assumed allowable at pre-determined time instants (Col 2, L32-33).

i) Regarding claim 15, Kung et al. disclose a method of frequency hopping for use in wireless equipment, the method comprising the steps of

dividing a hopping set into an allowable frequency set and a prohibited frequency set (Col 2, L45-47, imply as "at least 10 Khz"); and

transmitting information associated with the division of the hopping set to another wireless endpoint (30 in Fig. 1).

j) Regarding claim 16, Kung et al. disclose the method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set (Col 2, L24-31).

k) Regarding claim 17, Kung et al. disclose a wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period T (as shown in Fig. 2 and 3); and

a processor (34 in Fig. 1) for selecting a frequency from a set of N frequencies (Col 4, L62-63) such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies (Col 4, L 42-60).

l) Regarding claims 19, 21, 22 and 26, Kung et al. disclose a wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies (32 in Fig. 1), the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor (34 in Fig. 1) for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set.

m) Regarding claims 8, 9, 24 and 25, Kung et al. disclose a wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies (32 in Fig. 1), the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor (34 in Fig. 1) for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number F, where F: N, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d) adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F, (e) reducing the value of F; and (f) returning to (a) (Col 2 , L 32-47).

7. Claims 1, 3, 5, 6, 10,15, 17, 19, 21, 22, 24 and 26 are rejected under 35 U.S.C. 102(b) as being anticipated by Emi (5,541,954).

a) Regarding claims 1, 5, 6, 10, 15 and 17, Emi discloses a method for use in wireless equipment, the method comprising the steps of

transmitting signals using frequency hopping over a time period T (Fig. 7 and 8),

by selecting a frequency (Col 7, L 60- Col 8, L 4) from a set of N frequencies (Col 7, L 62-63) such that over at least a portion of the time period T (as shown in Fig 7 and 8),

the frequency selection is constrained to less than the N frequencies (Col 7, L 60- Col 8, L 4).

b) Regarding claim 3, 19, 21, 22, 24 and 26, Emi discloses a wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies (11 in Fig. 1A), the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor (17 in Fig. 1A) for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set (Col 6, L56 - Col 7, L1).

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 2, 4, 7, 11, 18, 20, 23 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kung et al. (4,654, 859).

Regarding claim 2, 4, 7, 11, 18, 20, 23 and 27, Kung et al. disclose all the subject matter described above, except the specific teaching of a selecting step selects the frequency pseudo-randomly.

However, it is well known in the art that a frequency hopping spread spectrum carrier hops on a predetermined pseudo random pattern. Therefore, it

would have been obvious to one of ordinary skill in the art at the time of invention was made to understand and realize that the frequency hopping communication system by Kung et al. select frequency pseudo-randomly.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eva Yi Zheng whose telephone number is 703-305-8699. The examiner can normally be reached on 7:30-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Chin can be reached on 703-305-4714. The fax phone number for the organization where this application or proceeding is assigned is 703-879-9306.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

Washington, D.C. 20231

or faxed to:

(703) 872-9314 (for Technology Center 2600 only)

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington, VA, Sixth Floor (Receptionist).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Technology Center 2600 Customer Service Office whose telephone number is (703) 306-0377.

Eva Yi Zheng
Examiner
Art Unit 2634

May 4, 2004

SHUWANG LIU
PRIMARY EXAMINER

2634 41

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 09/850,124

Filing Date: May 7, 2001

Applicant: Krishna BALACHANDRAN et al.

Group Art Unit: 2634

Examiner: Eva Y. Zheng

Title: ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM

Attorney Docket: 29250-000873/US

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

August 16, 2004

AMENDMENT

Sir:

Applicants are in receipt of the Office Action dated May 20, 2004 ("Office Action"), and respond as follows.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 9 of this paper.

IN THE CLAIMS

Kindly amend claims 1, 3, 5, 6, 8, 10, 15, 17, 19, 21, 24 and 26 and delete claims 2, 4, 7, 11, 18, 20, 23 and 27 without prejudice to, or disclaimer of, the subject matter therein. The subject matter of these deleted claims has been incorporated into other claims.

The following is a complete listing of revised claims with a status identifier in parenthesis.

LISTING OF CLAIMS

1. (Currently Amended) A method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period *T*, by

pseudorandomly selecting a frequency from a set of *N* frequencies such that over at least a portion of the time period *T*, the frequency selection is constrained to less than the *N* frequencies.

2. (Cancelled)

3. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies; and

pseudorandomly selecting frequencies from the set of hopping frequencies over a time period *T* by limiting the available frequencies from the hopping set over at least a portion of the time period *T*.

4. (Cancelled)

5. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *F* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

reducing the size of the hopping set over a portion of the time period *T* by at least one frequency.

6. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

pseudorandomly selecting frequencies from the hopping set over the time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.

7. (Cancelled)

8. (Currently Amended) A method of frequency hopping for use in wireless equipment, where a hopping set is initialized to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*, the method comprising the steps of:

determining a hopping index value;

modifying the hopping index value by at least the modulo of a number F, where $F \leq N$;

pseudorandomly selecting a hopping frequency from the hopping set of a function of the modified hopping index value;

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F;

reducing the value of F; and

returning to the determining step.

9. (Original) The method of claim 8 wherein the value of F reaches a predefined minimum value, further including the step of shifting the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

10. (Currently Amended) A method for frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T;

dividing the hopping set into an allowable frequency set and a prohibited frequency set;

pseudorandomly selecting frequencies from the allowable frequency set; and

after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set.

11. (Cancelled)

12. (Original) The method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time.

13. (Original) The method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to the other wireless endpoint through explicit signaling.

14. (Original) The method of claim 10 wherein all *N* frequencies in the hopping set are assumed allowable at pre-determined time instants.

15. (Currently Amended) A ~~method of~~ <u>pseudorandom</u> frequency hopping <u>method</u> for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a prohibited frequency set; and

transmitting information associated with the division of the hopping set to another wireless endpoint.

16. (Original) The method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set.

17. (Currently Amended) A wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period T; and

a processor for <u>pseudorandomly</u> selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies.

18. (Cancelled)

19. (Currently Amended) A wireless endpoint comprising:

a memory for storing a set of hopping frequencies; and

a processor for <u>pseudorandomly</u> selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T.

20. (Cancelled)

21. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising F frequencies, the hopping set used to <u>pseudorandomly</u> select therefrom hopping frequencies over a time period T; and

a processor for reducing the size of the hopping set over a portion of the time period T by at least one frequency.

22. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for pseudorandomly selecting frequencies from the hopping set over a time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.

23. (Cancelled)

24. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

a processor for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number *F* where $F \leq N$, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d) adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of *F*, (e) reducing the value of *F*; and (f) returning to (a).

25. (Original) The wireless endpoint of claim 24 wherein when the value of *F* reaches a predefined minimum value, the processor further shifts

the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for *F* and the minimum value, modulo *N*.

26. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) pseudorandomly selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set.

27. (Cancelled)

REMARKS

Response to Claim Rejections

The Office Action requests that the reference to "*N*" frequencies in claims 6 and 10 be changed to "*F*" frequencies. As indicated on at least page 5 of the specification, *N* is the total number of frequencies available for frequency hopping, while *F* is the number of frequencies in a hopping state, ***H***, over which a wireless endpoint is constrained to hop, where *F* is less than or equal to *N*. Therefore, Applicants respectfully submit that claims 6 and 10 appropriately indicate an initial hopping set of size *N* frequencies.

The Office Action also requests that claims 22, 24 and 26, which claim "a memory for storing a hopping set comprising *N* frequencies" should be changed to --a memory for storing a hopping set comprising *F* frequencies--. Similar to the objections to claims 6 and 10, Applicants respectfully submit that the present specification provides support for existing claims 22, 24 and 26.

Accordingly, Applicants respectfully request withdrawal of the pending objections and allowance of claims 6, 10, 22, 24 and 26.

The Section 112 Rejections

Claim 9 was rejected under 35 U.S.C. §112, the Office Action stating that the feature "the step of shifting" in claim 9, line 2, requires an antecedent basis. Applicants respectfully traverse this rejection for at least the following reasons.

As presently understood by Applicants' attorney, the Office Action appears to be objecting to the form of claim 9. However, it is respectfully submitted that when an additional step or method is claimed, the format "the step of" is appropriate and does not require an additional antecedent basis, e.g., "a" or "an"preceding step.

In addition, it is respectfully submitted that the scope of claim 9 can be reasonably ascertained by those skilled in the art and, therefore, is not indefinite (see MPEP 2173.05(e)).

Accordingly, Applicants respectfully request withdrawal of the pending rejection and allowance of claim 9.

Section 102 and 103 Rejections

Claims 1, 3, 5, 6, 8-10, 12-17, 19, 21, 22 and 24-26 were rejected under 35 U.S.C. §102(b) as being anticipated by Kung et al., U.S. Patent No. 4,654,859 ("Kung"). In addition, claims 1, 3, 5, 6, 10, 15, 17, 19, 21, 22, 24 and 26 were rejected under 35 U.S.C. §102(b) as being anticipated by Emi, U.S. Patent No. 5,541,954 ("Emi"). Finally, claims 2, 4, 7, 11, 18, 20, 23 and 27 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kung.

Applicants respectfully disagree and traverse these rejections for at least the following reasons.

As indicated in the Office Action, neither Kung nor Emi discloses or suggests the pseudorandom selection of a hopping frequency, as is required by each of the claims of the present invention. In fact, both references teach away from the use of a pseudorandom selection of a hopping frequency.

Kung selects a frequency by cycling through an ordered frequency set in a predetermined fashion. In contrast, the present invention pseudo-randomly selects a hopping frequency. The fact that Kung discloses the selection of a frequency by cycling through an ordered frequency set in a predetermined fashion, explicitly teaches away from pseudorandom selection of a hopping frequency, as is required by the claims of the present invention.

Emi appears to disclose a frequency hopping scheme where a receiver counts errors it has received on each given frequency. If a total error count exceeds some metric, then the received frequency will be deemed unusable and an alternative, unused frequency will be substituted in its place. There is nothing in Emi which teaches the pseudorandom selection of a hopping frequency, as is required by the claims of the present invention. One of ordinary skill in the art, on reading Emi would not equate Emi's substitution of a new frequency with pseudorandom frequency hopping selection, as is required by the claims of the present invention.

In the Office Action, it is stated that "it is well known in the art that a frequency hopping spread spectrum carrier hops on a predetermined pseudo

random pattern." Applicants wish to respectfully point out at least two things regarding this statement in the Office Action.

First, the claims do not require "a predetermined pseudorandom pattern." Instead, all that is required is a pseudorandom selection of a hopping frequency.

Second, Applicants respectfully submit that this is an inappropriate basis for rejecting the claims based on 35 U.S.C. §103(a). Only in limited circumstances should claims be rejected based on "common knowledge." Such a rejection, unsupported by documentary evidence should only be taken when the facts asserted to be common knowledge in the art are capable of instant and unquestionable demonstration of being so known.

Applicants respectfully submit that the pseudorandom selection of a hopping frequency from a set of N or F frequencies is not capable of instant and unquestionable demonstration as being well known, given the fact that none of the references cited in the Office Action discloses or even suggests such a feature.

Because there is no form of evidence offered in the Office Action to support an assertion of common knowledge or specific factual findings predicated on sound technical and scientific reason to support the rejection, Applicants respectfully request that the Section 103 rejections be withdrawn and claims 3, 4, 7, 11, 18, 20, 23 and 27 be allowed (see MPEP 2144.03).

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John E. Curtin at the telephone number of the undersigned below.

In the event this Response does not place the present application in condition for allowance, applicant requests the Examiner to contact the undersigned at (703) 668-8000 to schedule a personal interview.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By ______________________

John E. Curtin, Reg. No. 37,602
P.O. Box 8910
Reston, Virginia 20195
(703) 668-8000

JEC:psy

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/850,124	05/07/2001	Krishna Balachandran	21-1-3-12	1172

6980 7590 01/07/2005

TROUTMAN SANDERS LLP
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600 PEACHTREE STREET , NE
ATLANTA, GA 30308-2216

EXAMINER	
ZHENG, EVA Y	

ART UNIT	PAPER NUMBER
2634	

DATE MAILED: 01/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/850,124	BALACHANDRAN ET AL.
	Examiner	Art Unit
	Eva Yi Zheng	2634

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 August 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☐ Claim(s) _____ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *8-10,12-14 and 24-26* is/are allowed.

6)☒ Claim(s) *1,3,5,6,15-17,19,21 and 22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments with respect to claims 1, 3, 5, 6, 8-10, 12-17, 19, 21, 22 and 24-26 have been considered but are moot in view of the new ground(s) of rejection because of amendment.

Claim Objections

2. Claims 1, 4, 5, 6, 8, 9, 10, 14, 17, 21, 22 and 24-26 are objected to because of the following informalities: parameters: "N and F" are not defined.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1, 3, 15-17 and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by Munday et al. (US 5,377,221).

a) Regarding claim 1, Munday et al. disclose a method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period T (2A and 2B), by

pseudo randomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies (Col 2, L64-67).

b) Regarding claim 3, Munday et al. disclose a method for use in wireless equipment, the method comprising the steps of:

Storing a set of hopping frequencies (74 in Fig. 1; Col 6, L52-59); and

pseudo randomly selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T (Fig. 2A and 2B; Col 2, L64-67) .

c) Regarding claim 17, Munday et al. disclose a wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period T (2A and 2B; Col 2, L64-67); and

a processor for pseudo randomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies (26 in Fig. 1; Col 3, L61- Col 4, L15).

d) Regarding claim 15, Munday et al. disclose a pseudorandom frequency hopping method for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a probhibited frequency set (Col 2, L64 - Col 3, L17); and

transmitting information associated with the division of the hopping set to another wireless endpoint (Col 2, L64 - Col 3, L17).

e) Regarding claim 16, Munday et al. disclose the method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set (other wireless endpoint inherent as receiver; Col 2, L64 - Col 3, L17).

f) Regarding claim 19, Monday et al. disclose a wireless endpoint comprising:

a memory for storing a set of hopping frequencies (74 in Fig. 1; Col 6, L52-59); and

a processor for pseudo randomly selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping over at least a portion of the time period T (26 in Fig. 1; Col 3, L61- Col 4, L15).

5. Claims 1, 5, 6, 21 and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by Haartsen (US 6,345,066 B1).

a) Regarding claim 1, Haartsen discloses a method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period T (Fig. 1), by

pseudo randomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies (Fig. 2; Col 4, L 25-47).

b) Regarding claim 5, Haartsen discloses a method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of F frequencies, the hopping set used to pseudo randomly select therefrom hopping frequencies over a time period T (Col 4, L25-47); and

reducing the size of the hopping set over a portion of the timer period T by at least one frequency (Fig. 3; Col 5, L6-23).

c) Regarding claim 6, Haartsen discloses a method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T (Col 4, L25-47); and

pseudo randomly selecting frequencies from the hopping set (inherent as reduced set of frequencies) over the time period T such that at least one of the selected frequencies is prohibited from susbsequent selection in at least a portion of the time period T (Col 6, L31-57).

d) Regarding claim 21, Haartsen discloses a wireless endpoint comprising:

a memory for storing a hopping set comprising F frequencies (inherent as control 502 in Fig. 2), the hopping set used to pseudo randomly select therefrom hopping frequencies over a time period T (Col 4, L 25-47); and

a processor for reducing the size of the hopping set over a portion of the timer period T by at least one frequency (Fig. 3; Col 5, L6-23).

e) Regarding claim 22, Haartsen discloses a wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies (inherent as control 502 in Fig. 2), the hopping set used to select therefrom hopping frequencies over a time period T (Col 4, L 25-47); and

a processor for pseudo randomly selecting frequencies from the hopping set (inherent as reduced set of frequencies) over the time period T such that at least one of the selected frequencies is prohibited from susbsequent selection in at least a portion of the time period T (Col 6, L31-57).

Allowable Subject Matter

6. Claims 8-10, 12-14 and 24-26 are allowed.

7. The following is an examiner's statement of reasons for allowance:

None of the prior art teaches or suggests a frequency hopping method in a wireless system, a hopping set initialized to a size of N frequencies, and the hopping set used to select therefrom hopping frequencies over a time period of T, comprising the steps of: determining a hopping index value; modifying the hopping index value by at least the modulo of a number F, where F is less or equal to N; pseudo randomly selecting a hopping frequency from the hopping set of a function of the modified hopping index value; adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value F; reducing the value of F; and returning to the determining a hopping index value. .

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably

accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eva Yi Zheng whose telephone number is (571) 272-3049. The examiner can normally be reached on 7:30-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Chin can be reached on (571) 272-3056. The fax phone number for the organization where this application or proceeding is assigned is 703-879-9306.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

Washington, D.C. 20231

or faxed to:

(703) 872-9314 (for Technology Center 2600 only)

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington, VA, Sixth Floor (Receptionist).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Technology Center 2600 Customer Service Office whose telephone number is (703) 306-0377.

Eva Yi Zheng
Examiner
Art Unit 2634

January 3, 2005

Shuwang Liu

SHUWANG LIU
PRIMARY EXAMINER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	09/850,124
Filing Date:	May 7, 2001
Applicant:	Krishna BALACHANDRAN et al.
Group Art Unit:	2634
Examiner:	Eva Y. Zheng
Title:	ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM
Attorney Docket:	29250-000873/US

Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314
Mail Stop AF

April 5, 2005

REQUEST FOR RECONSIDERATION

Sir:

Applicants are in receipt of the Final Office Action dated January 7, 2005 ("Final Office Action"), and respond as follows.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 11 of this paper.

IN THE CLAIMS

Kindly amend claims 1, 3, 5, 8, 9, 10, 13, 14, 15, 17, 19, 21, 22, 24 and 26 as follows.

The following is a complete listing of revised claims with a status identifier in parenthesis.

LISTING OF CLAIMS

1. (Currently Amended) A method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period *T*, by

pseudorandomly selecting a frequency from a set of *N* frequencies such that over at least a portion of the time period *T*, the frequency selection is constrained to less than the *N* frequencies <u>and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*</u> [[.]]<u>,</u>

<u>where *N* is the total number of frequencies available for frequency hopping.</u>

2. (Cancelled)

3. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies; and

pseudorandomly selecting frequencies from the set of hopping frequencies over a time period *T* by limiting the available frequencies from the

hopping set over at least a portion of the time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.

4. (Cancelled)

5. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *F* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

reducing the size of the hopping set over a portion of the time period *T* by at least one frequency such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T* [[.]],

where *F* is the number of frequencies in a hopping state, *H*, over which a wireless endpoint is constrained to hop.

6. (Currently Amended) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

pseudorandomly selecting frequencies from the hopping set over the time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*[[.]],

where *N* is the total number of frequencies available for frequency hopping.

7. (Cancelled)

8. (Currently Amended) A method of frequency hopping for use in wireless equipment, where a hopping set is initialized to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*, the method comprising the steps of:

determining a hopping index value;

modifying the hopping index value by at least the modulo of a number *F*, where $F \leq N$;

pseudorandomly selecting a hopping frequency from the hopping set of a function of the modified hopping index value;

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of *F* and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*;

reducing the value of *F*; and

returning to the determining step[[.]],

where *N* is the total number of frequencies available for frequency hopping and where *F* is the number of frequencies in a hopping state, *H*, over which a wireless endpoint is constrained to hop.

9. (Currently Amended) The method of claim 8 wherein when the value of *F* reaches a predefined minimum value, further including the step of shifting the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for *F* and the minimum value, modulo *N*.

10. (Currently Amended) A method for frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*;

dividing the hopping set into an allowable frequency set and a prohibited frequency set;

pseudorandomly selecting frequencies from the allowable frequency set; and

after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T* [[.]],

where *N* is the total number of frequencies available for frequency hopping.

11. (Cancelled)

12. (Original) The method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time.

13. (Currently Amended) The method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to ~~the other~~ another wireless endpoint through explicit signaling.

14. (Original) The method of claim 10 wherein all *N* frequencies in the hopping set are assumed allowable at pre-determined time instants.

15. (Currently Amended) A pseudorandom frequency hopping method for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a prohibited frequency set; and

transmitting information associated with the division of the hopping set to another wireless endpoint <u>such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.</u>

16. (Original) The method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set.

17. (Currently Amended) A wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period T; and

a processor for pseudorandomly selecting a frequency from a set of N frequencies such that over at least a portion of the time period T, the frequency selection is constrained to less than the N frequencies and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T [[.]],

where N is the total number of frequencies available for frequency hopping.

18. (Cancelled)

19. (Currently Amended) A wireless endpoint comprising:

a memory for storing a set of hopping frequencies; and

a processor for pseudorandomly selecting frequencies from the set of hopping frequencies over a time period T by limiting the available frequencies from the hopping set over at least a portion of the time period T such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

20. (Cancelled)

21. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *F* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

a processor for reducing the size of the hopping set over a portion of the time period *T* by at least one frequency <u>such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*</u> [[.]]<u>,</u>

<u>where *F* is the number of frequencies in a hopping state, *H*, over which a wireless endpoint is constrained to hop.</u>

22. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for pseudorandomly selecting frequencies from the hopping set over a time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*[[.]]<u>,</u>

<u>where *N* is the total number of frequencies available for frequency hopping.</u>

23. (Cancelled)

24. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period T; and

a processor for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number F where $F \leq N$, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d) adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F <u>such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T</u>, (e) reducing the value of F; and (f) returning to (a) [[.]]<u>,</u>

<u>where N is the total number of frequencies available for frequency hopping and where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.</u>

25. (Original) The wireless endpoint of claim 24 wherein when the value of F reaches a predefined minimum value, the processor further shifts the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

26. (Currently Amended) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) pseudorandomly selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set <u>such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*</u> [[.]]<u>,</u>

<u>where *N* is the total number of frequencies available for frequency hopping.</u>

27. (Cancelled)

REMARKS

Claim Amendments

Claims 1, 3, 5, 8, 10, 15, 17, 19, 21, 24 and 26 have been amended to include a feature contained in claim 6 (and 22). As such, Applicants respectfully submit that these amendments do not require an additional search by the Examiner. Rather, these amendments place the claims in condition for allowance.

Claims 9 and 13 have been revised to correct for grammatical errors. These revisions are not related to the patentability of these, or other, claims.

The claims are patentable over the newly cited references to Munday et al. ("Mundy") and Haartsen ("Haartsen")

Each of the claims of the present invention includes the feature of pseudorandomly selecting a frequency or frequencies from a set of frequencies that has been constrained, reduced or limited "such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of [a] time period, *T*."

It is respectfully submitted that neither Munday nor Haartsen, taken separately or in combination, discloses or suggests such a prohibition on frequency selection.

Instead, it appears that after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited

from re-selecting a frequency, from a set of allowable frequencies, that has already been selected during a time period, *T*, as in the claims of the present invention.

Therefore, Applicants respectfully submit that neither Munday nor Haartsen can anticipate or render obvious the claims of the present invention.

Applicants respectfully request entry of the amendments referred to above, withdrawal of the pending rejections and allowance of claims 1, 3, 5, 6, 8-10, 12-17, 19, 21, 22 and 24-26.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John E. Curtin at the telephone number of the undersigned below.

In the event this Response does not place the present application in condition for allowance, applicant requests the Examiner to contact the undersigned at (703) 668-8000 to schedule a personal interview.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By ______________________

John E. Curtin, Reg. No. 37,602
P.O. Box 8910
Reston, Virginia 20195
(703) 668-8000

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MAIL STOP AF
RESPONSE UNDER
37 C.F.R. § 1.116
EXPEDITED PROCEDURE
EXAMINING GROUP 2634

PATENT
29250-000873/US

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant:	Krishna BALACHANDRAN et al.	Conf.:	1172
Appl. No.:	09/850,124	Group:	2634
Filed:	May 7, 2001	Examiner:	Eva Y. Zheng
For:	ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM		
Docket No.:	29250-000873/US		

NOTICE OF APPEAL FROM THE PRIMARY EXAMINER TO THE BOARD OF APPEALS

Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314
Mail Stop AF

April 5, 2005

Sir:

Applicants hereby appeal to the Board of Appeals from the decision dated January 7, 2005 of the Primary Examiner finally rejecting claims 1, 3, 5, 6, 15-17, 19, 21 and 22.

☐ The enclosed document is being transmitted via the Certificate of Mailing provisions of 37 C.F.R. § 1.8.

Applicants hereby petition for an extension of ______ (______) **month(s)** pursuant to 37 C.F.R. §§ 1.17 and 1.136(a).

The fee has been calculated as shown below:

04/06/2005 SFELEKE1 00000025 09850124
01 FC:1401 500.00 OP

☐ NO extensions of time have been previously obtained for responding to the Final Rejection. Thus a fee of $.00 is required for the full period of the above-requested extension of time.

☐ An extension of ______ (_____) **month(s)** for responding to the Final Rejection was previously requested and paid for on . Thus a fee of $ is required.

☐ Applicant claims small entity status. See 37 C.F.R. § 1.27.

The Government fee for filing a Notice of Appeal to the Board of Appeals is calculated as follows:

☒ Large entity - $500.00

☐ Small Entity - $250.00

Therefore, the TOTAL FEE due for the filing of this Notice of Appeal is $500.00.

Payment of the above TOTAL FEE is being made in the following manner:

☒ Check in the amount of $500.00 is enclosed.

☐ Please charge Deposit Account No. 08-0750 in the amount of $0.00. A triplicate copy of this sheet is attached.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By ______________________
John E. Curtin, Reg. No. 37,602

P.O. Box 8910
Reston, Virginia 20195
(703) 668-8000

JEC:psy

FEE TRANSMITTAL for FY 2005

Effective 10/01/2004. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 500

Complete if Known	
Application Number	09/850,124
Filing Date	May 7, 2001
First Named Inventor	Krishna BALACHANDRAN
Examiner Name	Eva Y. Zheng
Art Unit	2634
Attorney Docket No.	29250-000873/US

METHOD OF PAYMENT (check all that apply)

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 08-0750

Deposit Account Name: Harness, Dickey & Pierce, PLC

The Director is authorized to: *(check all that apply)*
☐ Charge fee(s) indicated below ☐ Credit any overpayments
☐ Charge any additional fee(s) during the pendency of this application
☐ Charge fee(s) indicated below, **except for the filing fee**
to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1011	300	2011	150	Utility filing fee	
1012	200	2012	100	Design filing fee	
1013	200	2013	100	Plant filing fee	
1014	300	2014	150	Reissue filing fee	
1005	200	2005	100	Provisional filing fee	

SUBTOTAL (1) ($) 0

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims		-20 ** =	0	X		=	0
Independent Claims		-3 ** =	0	X		=	0
Multiple Dependent						=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	50	2202	25	Claims in excess of 20
1201	200	2201	100	Independent claims in excess of 3
1203	360	2203	180	Multiple dependent claim, if not paid
1204	200	2204	100	** Reissue independent claims over original patent
1205	50	2205	25	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

***or number previously paid, if greater; For Reissues, see above*

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	120	2251	60	Extension for reply within first month	
1252	450	2252	225	Extension for reply within second month	
1253	1020	2253	510	Extension for reply within third month	
1254	1,590	2254	795	Extension for reply within fourth month	
1255	2,160	2255	1080	Extension for reply within fifth month	
1401	500	2401	250	Notice of Appeal	
1402	500	2402	250	Filing a brief in support of an appeal	500
1403	1000	2403	500	Request for oral hearing	
1452	500	2452	250	Petition to revive – unavoidable	
1453	1500	2453	750	Petition to revive – unintentional	
1501	1400	2501	700	Utility issue fee (or reissue)	
1502	800	2502	400	Design issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	790	2809	395	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	790	2810	395	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	790	2801	395	Request for Continued Examination (RCE)	

Other fee (specify) ____

***Reduced by Basic Filing Fee Paid** SUBTOTAL (3) ($)500

4. SEARCH/EXAMINATION FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1111	500	2111	250	Utility Search Fee	
1112	100	2112	50	Design Search Fee	
1113	300	2113	150	Plant Search Fee	
1114	500	2114	250	Reissue Search Fee	
1311	200	2311	100	Utility Examination Fee	
1312	130	2312	65	Design Examination Fee	
1313	160	2313	80	Plant Examination Fee	
1314	600	2314	300	Reissue Examination Fee	

SUBTOTAL (4) ($)0

SUBMITTED BY			Complete (if applicable)		
Name (Print/Type)	John E. Curtin	*Registration No. (Attorney/Agent)*	37,602	*Telephone*	(703) 668-8000
Signature				*Date*	April 29, 2005

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Serial No. 09/850,124
Atty. Ref. 29250-000873/US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appeal No. ______________

Appellants:	Krishna BALACHANDRAN et al.
Application No.:	09/850,124
Group No.:	2634
Filed:	May 7, 2001
Examiner:	Eva Y. Zheng
For:	ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM
Attorney Docket No.:	29250-000873/US

BRIEF ON APPEAL ON BEHALF OF APPELLANT

Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314
Mail Stop Appeal Brief - Patents

April 29, 2005

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BRIEF ON BEHALF OF APPELLANT

In support of the Notice of Appeal filed April 5, 2005, appealing the Examiner's Final Office Action mailed January 7, 2005 rejecting each of pending claims 1, 3, 5, 6, 15-17, 19, 21 and 22 of the present application which appear in the attached Appendix A, Appellant hereby provides the following remarks.

I. REAL PARTY IN INTEREST

The present application is assigned to Lucent Technologies Inc., by an Assignment recorded on August 24, 2001, Reel 012109, Frame 0573.

II. RELATED APPEALS AND INTERFERENCES

The Appellant does not know of any appeals or interferences which would directly affect or which would be directly affected by, or have a bearing on, the Board's decision in this Appeal.

III. STATUS OF THE CLAIMS

The claims reproduced in the attached Appendix A are the claims on appeal. Each of these claims is currently pending in the application.

In addition, Appellants note that the Examiner has admitted that claims 8-10, 12-14 and 24-26 (also included in Appendix A) contain allowable subject matter and would be allowable if rewritten in independent form. Accordingly, irrespective of the outcome of this Appeal, Appellants reserve the right to re-write any and all of these objectionable claims into independent form to place them in condition for allowance.

IV. STATUS OF ANY AMENDMENTS FILED SUBSEQUENT TO THE FINAL REJECTION

A Request for Reconsideration ("Request") dated April 5, 2005 was filed with the U.S. Patent and Trademark Office in response to the Final Office Action. In an April 20, 2005 Advisory Action, this Request was considered but not entered by the Examiner.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

Advances in wireless technologies have propelled a migration in features and services provided to the end user. Network operators may, however, need to support multiple and perhaps migratory technologies with limited spectrum. Therefore, radio resource management techniques that improve spectral efficiency and/or system capacity are always of interest to network operators.

Higher spectral efficiency and/or voice capacity can be achieved in the Global System for Mobile Communication (GSM) Enhanced Data rates for Global Evolution (EDGE) Radio Access Network (GERAN) through tight frequency reuse (e.g., 1/3 or 1/1 reuse). Current GSM deployments employ techniques such as frequency hopping in order to combat the effects of fading and interference. The performance improvement achieved through frequency hopping for voice users at the link and system level directly translates into higher capacity.

On a GSM full rate traffic channel, 20 ms (milli-second) speech frames are convolutionally encoded and diagonally interleaved over a sequence of 8 bursts in a time slot. In the case of a half rate channel, speech is coded and diagonally interleaved over a sequence of 4 alternate bursts in a time slot. Frequency hopping is carried out burst by burst in order to mitigate the effects of slow fading and interference. It provides the following benefits: fading diversity, interferer diversity, and interference averaging (excerpts from specification, p. 1).

In practical systems, frequency hopping is typically non-ideal and the benefits of fading and interferer diversity are not fully realized. With respect to frequency hopping techniques, GSM specifies cyclic frequency hopping and pseudo-random frequency hopping (e.g., see 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)"). If the number of frequencies is sufficient, then cyclic hopping provides full fading diversity. (As referred to herein, full fading diversity is where every burst within the interleaving depth of a speech frame experiences an independent fading state. This is possible only if the number of frequencies is greater than the number of bursts over which a speech frame is interleaved and the frequencies are sufficiently separated from each other.) However, cyclic hopping does not provide the benefits of interferer diversity and interference averaging. The pseudo-random frequency hopping algorithm

specified in GSM provides interferer diversity and achieves long-term interference averaging but does not guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth of a speech 10 frame (excerpts from specification, pp. 1-2).

With respect to GSM pseudo-random frequency hopping, if a large amount of spectrum is allocated, then there are many frequencies over which users can hop and repeated frequencies over a short interval are not common. However, in limited spectrum scenarios where the number of frequencies are smaller than the number of bursts over the interleaving depth (40 ms in the speech case), frequency repetitions always occur. This is illustrated in FIG. 1 (Appendix B) on a full rate traffic channel. For full-rate voice users, eight bursts are transmitted over pseudo-randomly generated frequencies (it is assumed for this example that there are eight frequencies to select from: f_0 to f_7). As can be observed from FIG. 1, coded speech frame 1 encounters frequency, f_4, on 3 out of the 8 bursts that it is interleaved across. This implies that speech frame 1 experiences only 6 out of 8 possible independent fading states (assuming there is sufficient separation between each of the frequencies). Similarly, it can be observed for speech frame 2 that frequencies, f_2,f_4 and f_5 are repeated two times each on the 8 bursts over which coded speech frame 2 is interleaved. In this case, speech frame 2 experiences only 5 out of 8 possible independent fading states. In other words, the GSM pseudo-random frequency hopping algorithm does not maximize the number of unique

frequencies (or independent fading states) in this case. This has consequences for low mobility users where the fading tends to be strongly correlated for time duration in excess of the interleaving depth of a speech frame. In this case, users may hop to the same frequency multiple times, experiencing similar channel fading conditions each time. With typical channel coding schemes employed for speech traffic channels and control signaling channels, increased correlation within the interleaving depth can lead to degradation in error performance (excerpts from specification, pp. 2-3).

Familiarity with GSM is assumed and is not described herein. For example, other than the inventive concept, a form of frequency hopping used in GSM is described in 3GPP TS 45.002, "3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)." In addition, the inventive concept is implemented using conventional programming techniques, which as such, will not be described herein.

FIG. 2 (Appendix C) shows a high-level block diagram of a representative wireless endpoint 200 for use in accordance with the principles of the invention. Other than the inventive concept, the elements shown in FIG. 2 are well known and will not be described in detail. Wireless endpoint 200 represents a stored-program-control-based processor architecture and includes processor 250, memory 260 (for storing program instructions and data (such

as a set of hopping frequencies), as further described below) and communications interface(s) 265 for coupling to one or more wireless communication paths as represented by path 266 (e.g., 265 represents a wireless transmitter and a wireless receiver). In the context of this invention, e.g., processor 250 and memory 260 implement (among other functions not described herein) a constrained frequency hopping method for selecting frequencies for use in transmission of signals via communications interface 265. A detailed description of the reception and transmission of wireless signals is not necessary for the inventive concept and, as such, is not described herein. Except as noted below, it is assumed that the wireless endpoint 200 is a part of a GSM system (not shown) and is in communication with another wireless endpoint (not shown). Wireless endpoint 200 is representative of any wireless device, e.g., a base station, mobile station, user terminal, etc. (excerpts from specification, pp. 3-4).

In accordance with the invention, hopping frequency sequences are constrained in order to reduce, or minimize, repeated frequencies over a time period T. Consider a class of hopping sequences for which constraints are imposed to minimize repeated frequencies. For example, if the total number of frequencies, N in a hopping set is equal to 4, the hopping sequence is constrained to prevent any repeats within a set of four bursts. Thus across two consecutive sets of four bursts, no frequency would be repeated three or more times.A similar case can be made for $N = 8$. In this case, a constrained

hopping sequence prevents the repetition of any frequency over 8 consecutive bursts (i.e., it guarantees independent fading states). Hence, the maximum frequency repeat across an 8-tuple would be 1. This is shown in FIG. 3 (Appendix D) for an illustrative speech frame 1, which illustrates constrained frequency hopping on a full rate traffic channel. It should be noted that although the negative effects of frequency repetitions decrease for GSM hopping sets with larger values of N, e.g., $N = 12$, the inventive concept still provides improvement.

In accordance with the invention, a hopping state, $\boldsymbol{H}$, is defined to be:

$$\boldsymbol{H} = \{H_0, H_1, \ldots, H_{F-1}, H_F, \ldots, H_{N-1}\}, \tag{1}$$

which is a vector of length N, where N is the total number of frequencies available to hop over, and F is $\leq N$ and is the number of frequencies in $\boldsymbol{H}$ over which the wireless endpoint is constrained to hop. $\boldsymbol{H}$ can also be defined as $\boldsymbol{H} = \boldsymbol{A} \cup \boldsymbol{B}$, where

$$\boldsymbol{A} = \{H_0, H_1, \ldots, H_{F-1}\}, \tag{2}$$

and is the set of F frequencies over which a wireless endpoint is currently allowed to hop and

$$\boldsymbol{B} = \{H_F, \ldots, H_{N-1}\} \tag{3}$$

and is the set of $(N - F)$ frequencies over which a wireless endpoint is not currently allowed to hop. In other words, $\boldsymbol{H}$ can be viewed as being divided into a set of allowable frequencies (**A**) and a set of prohibited frequencies (**B**). Let the

range of F be defined by F_{min} and F_{max}, where $0 \le F_{min} < F_{max} \le N$ (excerpts from specification, pp. 4-5).

For each hop (hops occur every 4.615 ms frame in the case of GSM), the transmitter and receiver (of corresponding wireless endpoints as represented by wireless endpoint 200 of FIG. 2) first use the following procedure in order to determine a pseudo-random frequency index, S (also referred to herein as a hopping index sequence value). Steps (4) through (8), below, are found in section 6.2.3 of the above-mentioned standard, 3GPP TS 45.002. Values for M (where $0 \le M \le 152$) and S (where $0 \le S \le N - 1$) are computed as follows:

$$M = T2 + RNTABLE\ ((HSN xor\ TIR) + T3); \quad (4)$$

$$M' = M \text{ modulo } (2\text{^ } NBIN); \quad (5)$$

$$T' = T3 \text{ modulo } (2\text{^}NBIN); \quad (6)$$

if $M' < N$, then (7)

$$S = M'; \quad (8)$$

else,

$$S = (M' + T') \text{ modulo } N; \quad (9)$$

where the parameters used above are defined in Table One, which is shown in FIG. 4 (Appendix E) (additional information on the parameters shown in Table One are found in the above-mentioned standard - 3GPP TS 45.002) (excerpts from specification, pp. 5-6).

Normally, S is used to select one of the frequencies from **H**. However, and in accordance with the invention, this pseudo-random frequency index,

S, is now used to select one of the allowable frequencies in ***A***. Note, that the pseudo-random frequency index *S* corresponds to the Mobile Allocation Index (MAI) that is generated by the GSM hopping algorithm for non-zero HSN (Hopping Sequence Number) and MAIO = 0, where MAIO is the Mobile Allocation Index Offset. (In the generation of the pseudo-random frequency index, *S*, as described below for the inventive concept, MAID=O is employed for all users in a sector to ensure that users within a sector choose identical indices of ***H***. This guarantees that the hopping states are identical between all users within a sector. In GSM, each user in a sector is assigned a unique MAIO. This ensures that the frequency hopping sequences between users in the same sector are orthogonal. This concept still applies when using the inventive concept described below (e.g., see equation (11), below) as modulo addition of the MAIO guarantees no intra-sector collisions.) Now, let the sequence of pseudo-random frequency indices generated by the above-described algorithm be $\mathbf{S} = \{S_0, S_1, S_2, \ldots\}$. Note that $S_i \in \{0, 1, .., N\text{-}I\}$ can be larger than the number of allowable frequencies *F*. Therefore, in this constrained hopping algorithm, a wireless endpoint hops to:

$$\text{Hopping Frequency} = (Hs + \text{MAIO}) \text{ modulo } N \text{ where} \quad (10)$$

$$S' = (S_i) \text{ modulo } F. \quad (11)$$

In other words, and in accordance with the invention, *S'* is restricted to the allowable set, **A** (excerpts from specification, p. 6).

Turning now to FIG. 5 (Appendix F), an illustrative flow chart is shown for updating the hopping state for a constrained frequency hopping method in accordance with the principles of the invention. In steps 505, 510 and 515, the value of the currently hopped frequency, H_R, is swapped (via the variable *c*) with H_{F-1}, the last allowable frequency in **A**. Thus, the currently hopped frequency becomes the last element in the set **A**, at position *F-1*. In the step 520, the size of ***A*** is reduced by decrementing ***F*** by one so that the set of frequencies over which the user can hop for the next burst is reduced (thus, excluding the currently hopped frequency, which is now effectively inserted into B). In step 525, if *F* reaches a pre-determined minimum value, F_{min}, (e.g., 0), ***F*** is reset to *F*,n" and ***H*** is cyclically shifted to the right by (F,,,,, - *Fmi,) modulo N*, and A is set equal to the first F_{max} elements of **H** (while **B** = **H-A** (which in some instances my be the null set)). In this way, the oldest candidates in ***H*** can be considered once again.

Consider an example with the following parameters:

$N = 8$ frequencies;

$F_{min} = 0$, $F_{max} = 4$;

Initial hopping state ***H*** = *{*1 3 4 6 2 0 5 7*}* (obviously, each number in ***H*** corresponds to an a priori assigned frequency); and

Initial value of $F = 4$.

Table Two, shown in FIG. 6 (Appendix G), illustrates the constrained frequency hopping method when the GSM hopping index sequence, **S**, is illustratively equal to {1 5 2 4 1...} for the first 5 bursts (burst number 0 through burst number 4). As can be observed from Table Two, the first column shows the burst number; the second column shows the associated value of the hopping index sequence for that burst number (taken from S = {1 5 2 4 1 ...}); the third column illustrates the allowable frequency set **A**; the fourth column shows the computed hop frequency in accordance with equations (10) and (11), above; the fifth column shows the updating of **H** (or equivalently **A** (and **B** for that matter)) using the method shown in FIG. 5; and the sixth column illustrates the value of F (excerpts from specification, pp. 6-7).

As noted above, and shown in the first row of Table Two, the initial set of hopping frequencies is **H** = {1 3 4 6 2 0 5 7} and $F = 4$. As such, for the first burst number of 0, **A** is effectively set equal to the first four hopping frequencies of H, as shown in row *2* of Table Two (and the remaining frequencies of **H** are a part of **B**). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 2 of Table Two, i.e., $H_1 = 3$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = { 1 6 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *1* is exchanged with the frequency value at index position *(F - 1)*. In this example, 3 is exchanged with 6 at the 1st and 3rd positions (recalling

that the position index begins at 0). Finally, F is adjusted to 3, as shown in the final column entry for row 2 of Table Two (excerpts from specification, pp. 7-8).

As a result, since F is now equal to 3, for the next burst number of 1, the next hop frequency is now restricted to 1, 6, or 4 since the size of **A** has been reduced as shown in row 3 of Table 2. (Alternatively, the allowed frequency selections from **H** have been constrained to the first three frequencies.) The hop frequency is computed in accordance with equation (11), above, with the result shown in row 3 of Table Two, i.e., $H_2 = 4$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {1 6 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *2* is exchanged with the frequency value at index position (F - *1*). In this example though the positions are the same since the selected index position and the value of F are the same, i.e., 3. Therefore, the ordering of the frequencies in **H** does not change. Finally, F is adjusted to 2, as shown in the final column entry for row 3 of Table Two.

For the next burst number of 2, the next hop frequency is now restricted to 1 and 6 since the size of **A** has been reduced as shown in row 4 of Table 2 (since F now equals 2). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 4 of Table Two, i.e., $H_0 = 1$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed index position 0 is exchanged with the frequency value at index position *(F - 1)*.

In this example, 1 is exchanged with 6 at the 0th and 1st positions. Finally, F is adjusted to 1, as shown in the final column entry for row 4 of Table Two.

For the next burst number of 3, the next hop frequency is now restricted to 6 since the size of **A** has been reduced as shown in row 5 of Table 2 (since F now equals 1). The hop frequency is computed in accordance with equation (11), above, with the result shown in row 5 of Table Two, i.e., $H_0 = 6$. **H** is now adjusted as shown in the flow chart of FIG. 5, i.e., **H** = {6 1 4 3 2 0 5 7}. In other words, the frequency value at the computed index position *0* is exchanged with the frequency value at index position $(F - 1)$. In this example though the positions are the same since the selected index position and the value of F are the same, i.e., 0. As such, the ordering of the frequencies in H does not change. Finally, F is adjusted to 0, as shown in the final column entry for row 5 of Table Two. However, this update to F indicates that the minimum value is reached and hence, $\boldsymbol{H}$ is cyclically shifted by $(F_{max} - F_{min})$ mod $N = 4$ and F is reset to $F_{max} = 4$. This is shown by the additional entries in row 5 of columns 5 and 6 of Table Two, where now **H** = {2 0 5 7 6 1 4 3} and $F = 4$. Consequently, for the next burst number of 4, the size of **A** has been increased as shown in row 6 of Table 2 (since F now equals *4)* and **A** = {2 0 5 7}. As a result of this constrained frequency hopping method, the hop sequence for the first 5 burst numbers is: 3, 4, 1, 6, (of course assuming that the MAIO associated with this user equals 0, else refer to equation (11)) (excerpts from specification, pp. 8-9).

This algorithm is stated in a general way to allow flexibility in the actual implementation. Although the proposed change ultimately alters the hopping sequence, this algorithm uses the existing GSM hopping framework thus allowing legacy mobiles to be easily supported. In addition, the similarity to the current GSM hopping algorithm allows this feature to be turned off for cases such as large spectrum deployments where little to no gains do not warrant the additional complexity. In such cases, the regular GSM hopping algorithm can be employed.

Note, it is recommended that wireless endpoints run the proposed algorithm at all times, even during silence, in order to maintain the hopping state. Maintaining hopping states is needed to ensure that there are no intra-sector collisions. Since the algorithm considers consecutive bursts spanning multiple frames, the algorithm easily applies to full rate voice (diagonally interleaved) and data (block interleaved) services. The algorithm also applies to half rate voice if $N \geq 8$.

The following should be noted with respect to protocol aspects. When a user enters the system (e.g. at the start of a voice call), the wireless endpoint must know the hopping state, $\boldsymbol{H}$, the number of currently allowable frequencies, F, and the range of F defined by $Fmin$ and $Fmax$ where $0 \leq Fmin \leq Fmax \leq F$. $Fmin$ and Fmax are assumed to be provided during call setup. The network can provide $\boldsymbol{H}$ and F to a wireless endpoint (e.g., a user terminal) in any number of ways, such as:

1) These parameters can be provided during call setup signaling from another wireless endpoint along with an associated timestamp by suitable modification of messages used in existing call setup protocols. Since the algorithm to reconstruct the time evolution of $\boldsymbol{H}$ and F are known, either wireless endpoint can then determine the state information at the current time (effectively providing information on **A**, etc.); or

2) Alternatively, state information can be autonomously derived at a wireless endpoint by refreshing the state information at pre-determined time instants. For example, the state can be refreshed (i.e., $\boldsymbol{H} = \{H_0, H_1, \ldots, H_{N-1}\}$, $F = Fmax$) at pre-determined time instants. The wireless endpoint can then reconstruct the time evolution of $\boldsymbol{H}$ and F from the previous refresh instant to the current time.

(excerpts from specification, pp. 9-10)

As described above, and in accordance with the invention, a constrained hopping sequence has been described for reducing the rate at which frequencies are repeated (or alternatively, maximizes the number of independent fading states). The use of constrained frequency hopping allows GSM pseudo-random frequency hopping to achieve full fading diversity under spectrum constraints within the interleaving depth of a speech frame. As such, the constrained hopping algorithm maximizes the number of unique

frequencies that occur over the interleaving depth of a speech frame. This permits an improvement in fading diversity performance with negligible impact on interferer diversity and interference averaging capability of the existing GSM pseudo-random hopping algorithm.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope. For example, although illustrated in the context of pseudo-random frequency selection, other selection methods may be used. Also, although shown as a separate elements, any or all of the elements of FIG. 1 (e.g., 260) may be implemented in a stored-program-controlled processor (excerpts from specification, pp. 10-11).

Appellants respectfully note that the above summary of the invention, including any indication of reference numerals, drawings, figures, paragraphs, page numbers, etc. (collectively referred to as "descriptions" of the application) have been provided solely to comply with the U.S. Patent and Trademark Office's rules concerning the appeal of the claims of the present application. As such, the descriptions above are merely exemplary and should not be construed to limit the claims of the present application in any way whatsoever.

VI. ISSUES TO BE REVIEWED ON APPEAL

(i.) Whether or not claims 1, 3, 15-17 and 19 are anticipated by U.S. Patent No. 5,377,221 to Munday et al. ("Munday").

(ii.) Whether of not claims 1, 5, 6, 27 and 22 are anticipated by U.S. Patent No. 6,345,066 to Haartsen ("Haartsen").

VII. ARGUMENTS

The claims are patentable over the newly cited references to Munday and Haartsen

Each of the claims of the present invention includes the feature of pseudorandomly selecting a frequency or frequencies from a set of frequencies that has been constrained, reduced or limited "such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of [a] time period, *T*."

It is respectfully submitted that neither Munday nor Haartsen, taken separately (or in combination), discloses or suggests such a prohibition on frequency selection.

Instead, it appears that after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited from re-selecting a frequency, from a set of allowable frequencies, that has

already been selected during a time period, *T*, as in the claims of the present invention.

Therefore, Applicants respectfully submit that neither Munday nor Haartsen can anticipate (or render obvious) the claims of the present invention.

IX. CONCLUSION

Accordingly, for at least the aforementioned reasons, Appellants respectfully request the Honorable Members of the Board of Patent Appeals and Interferences to reverse each of the outstanding rejections in connection with the present application and allow each of the pending claims 1, 3, 5, 6, 15-17, 19, 21 and 22 in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No.08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By: ______________________

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JEC:psy

APPENDIX A

1. (Previously Presented) A method for use in wireless equipment, the method comprising the steps of:

transmitting signals using frequency hopping over a time period *T*, by

pseudorandomly selecting a frequency from a set of *N* frequencies such that over at least a portion of the time period *T*, the frequency selection is constrained to less than the *N* frequencies and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*,

where *N* is the total number of frequencies available for frequency hopping.

2. (Cancelled)

3. (Previously Presented) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

storing a set of hopping frequencies; and

pseudorandomly selecting frequencies from the set of hopping frequencies over a time period *T* by limiting the available frequencies from the hopping set over at least a portion of the time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.

4. (Cancelled)

5. (Previously Presented) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *F* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

reducing the size of the hopping set over a portion of the time period *T* by at least one frequency such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*,

where *F* is the number of frequencies in a hopping state, *H*, over which a wireless endpoint is constrained to hop.

6. (Previously Presented) A method of frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

pseudorandomly selecting frequencies from the hopping set over the time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*,

where *N* is the total number of frequencies available for frequency hopping.

7. (Cancelled)

8. (Previously Presented) A method of frequency hopping for use in wireless equipment, where a hopping set is initialized to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T, the method comprising the steps of:

determining a hopping index value;

modifying the hopping index value by at least the modulo of a number F, where $F \leq N$;

pseudorandomly selecting a hopping frequency from the hopping set of a function of the modified hopping index value;

adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T;

reducing the value of F; and

returning to the determining step,

where N is the total number of frequencies available for frequency hopping and where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

9. (Previously Presented) The method of claim 8 wherein when the value of F reaches a predefined minimum value, further including the step of shifting the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

10. (Previously Presented) A method for frequency hopping for use in wireless equipment, the method comprising the steps of:

initializing a hopping set to a size of N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T;

dividing the hopping set into an allowable frequency set and a prohibited frequency set;

pseudorandomly selecting frequencies from the allowable frequency set; and

after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

where N is the total number of frequencies available for frequency hopping.

11. (Cancelled)

12. (Original) The method of claim 10 wherein membership in the allowable frequency set and the prohibited frequency set at a current time is derived from knowledge of the allowable frequency set and the prohibited frequency set at an earlier time.

13. (Previously Presented) The method of claim 10 wherein knowledge of the allowable frequency set and the prohibited frequency set at a particular time is provided by one wireless endpoint to another wireless endpoint through explicit signaling.

14. (Original) The method of claim 10 wherein all N frequencies in the hopping set are assumed allowable at pre-determined time instants.

15. (Previously Presented) A pseudorandom frequency hopping method for use in wireless equipment, the method comprising the steps of:

dividing a hopping set into an allowable frequency set and a prohibited frequency set; and

transmitting information associated with the division of the hopping set to another wireless endpoint such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T.

16. (Original) The method of claim 15 wherein the transmitted information enables the other wireless endpoint to derive the allowable frequency set.

17. (Previously Presented) A wireless endpoint comprising:

a transmitter for transmitting signals using frequency hopping over a time period *T*; and

a processor for pseudorandomly selecting a frequency from a set of *N* frequencies such that over at least a portion of the time period *T*, the frequency selection is constrained to less than the *N* frequencies and such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T* ,

where *N* is the total number of frequencies available for frequency hopping.

18. (Cancelled)

19. (Previously Presented) A wireless endpoint comprising:

a memory for storing a set of hopping frequencies; and

a processor for pseudorandomly selecting frequencies from the set of hopping frequencies over a time period *T* by limiting the available frequencies from the hopping set over at least a portion of the time period *T* such that at

least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*.

20. (Cancelled)

21. (Previously Presented) A wireless endpoint comprising:

a memory for storing a hopping set comprising *F* frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period *T*; and

a processor for reducing the size of the hopping set over a portion of the time period *T* by at least one frequency such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T* ,

where *F* is the number of frequencies in a hopping state, *H*, over which a wireless endpoint is constrained to hop.

22. (Previously Presented) A wireless endpoint comprising:

a memory for storing a hopping set comprising *N* frequencies, the hopping set used to select therefrom hopping frequencies over a time period *T*; and

a processor for pseudorandomly selecting frequencies from the hopping set over a time period *T* such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period *T*,

where N is the total number of frequencies available for frequency hopping.

23. (Cancelled)

24. (Previously Presented) A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to pseudorandomly select therefrom hopping frequencies over a time period T; and

a processor for (a) determining a hopping index value, (b) modifying the hopping index value by at least the modulo of a number F where $F \leq N$, (c) selecting a hopping frequency from the hopping set as a function of the modified hopping index value, (d) adjusting the order of the hopping set such that the selected hopping frequency is now at a position corresponding to the value of F such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T, (e) reducing the value of F; and (f) returning to (a),

where N is the total number of frequencies available for frequency hopping and where F is the number of frequencies in a hopping state, H, over which a wireless endpoint is constrained to hop.

25. (Original) The wireless endpoint of claim 24 wherein when the value of F reaches a predefined minimum value, the processor further shifts the hopping set in a cyclical direction by a value equal to a difference between a predefined maximum value for F and the minimum value, modulo N.

26. (Previously Presented) A wireless endpoint comprising:

a memory for storing a hopping set comprising N frequencies, the hopping set used to select therefrom hopping frequencies over a time period T; and

a processor for (a) dividing the hopping set into an allowable frequency set and a prohibited frequency set, (b) pseudorandomly selecting frequencies from the allowable frequency set, and (c) after at least one frequency selection, adjusting the membership in the allowable frequency set and the prohibited frequency set such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T,

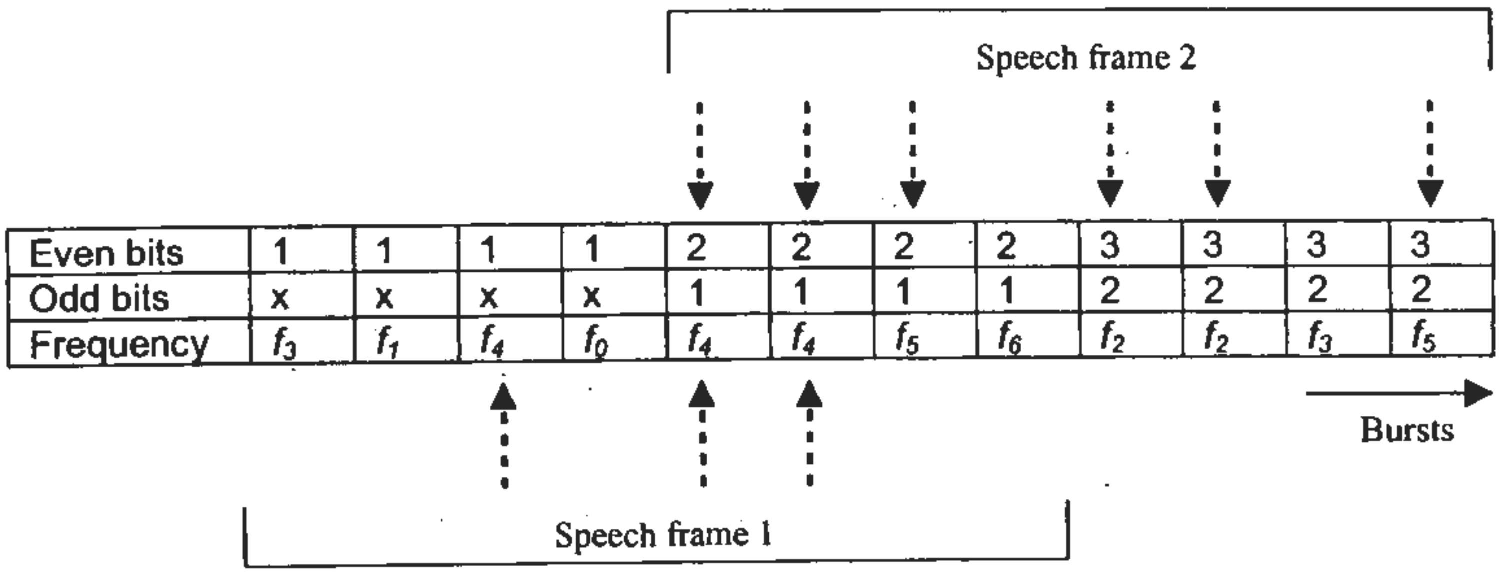
where N is the total number of frequencies available for frequency hopping.

27. (Cancelled)

Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 1

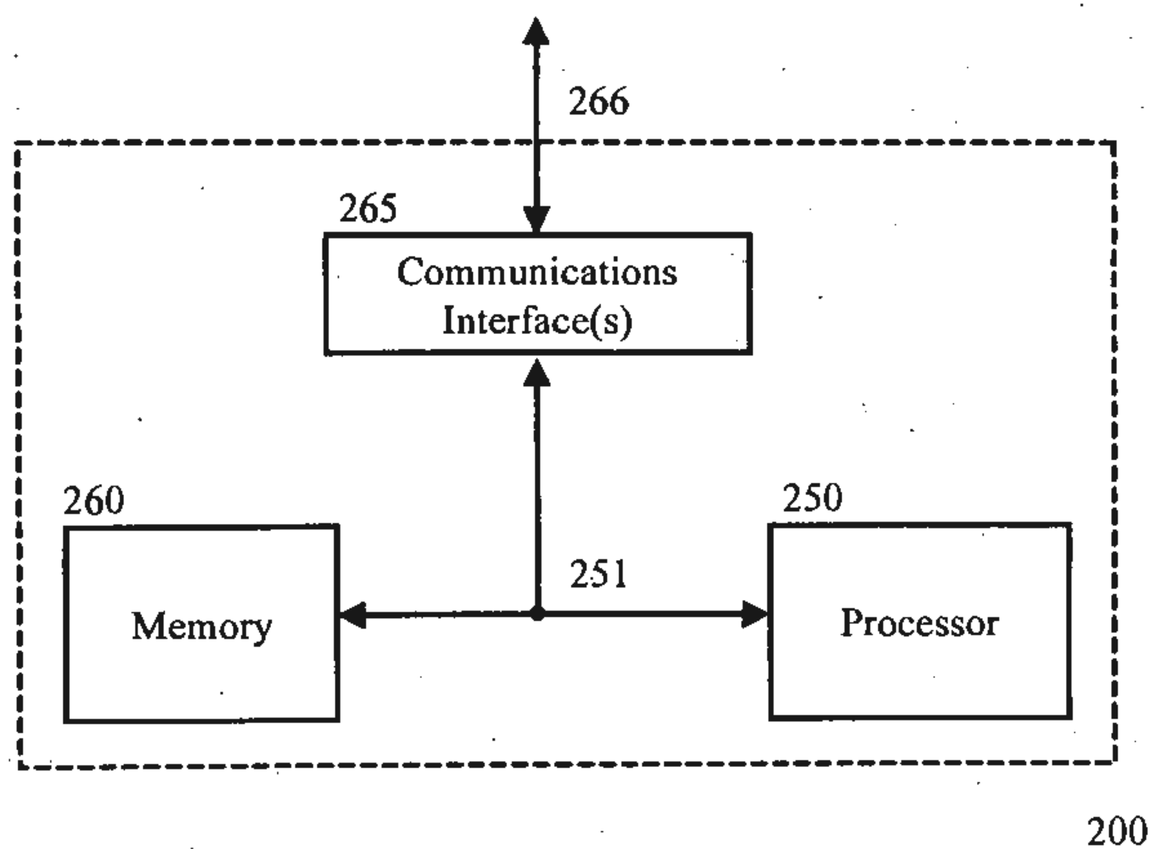
Prior Art



Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_4	f_4	f_5	f_6	f_2	f_2	f_3	f_5

APPENDIX B

FIG. 2 Balachandran-Kang-Sanwal-Seymour 21-1-3-12



APPENDIX C

Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 3

Even bits	1	1	1	1	2	2	2	2	3	3	3	3
Odd bits	x	x	x	x	1	1	1	1	2	2	2	2
Frequency	f_3	f_1	f_4	f_0	f_7	f_8	f_5	f_6	f_1	f_3	f_0	f_4

Speech frame 1

Bursts

APPENDIX D

Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 4

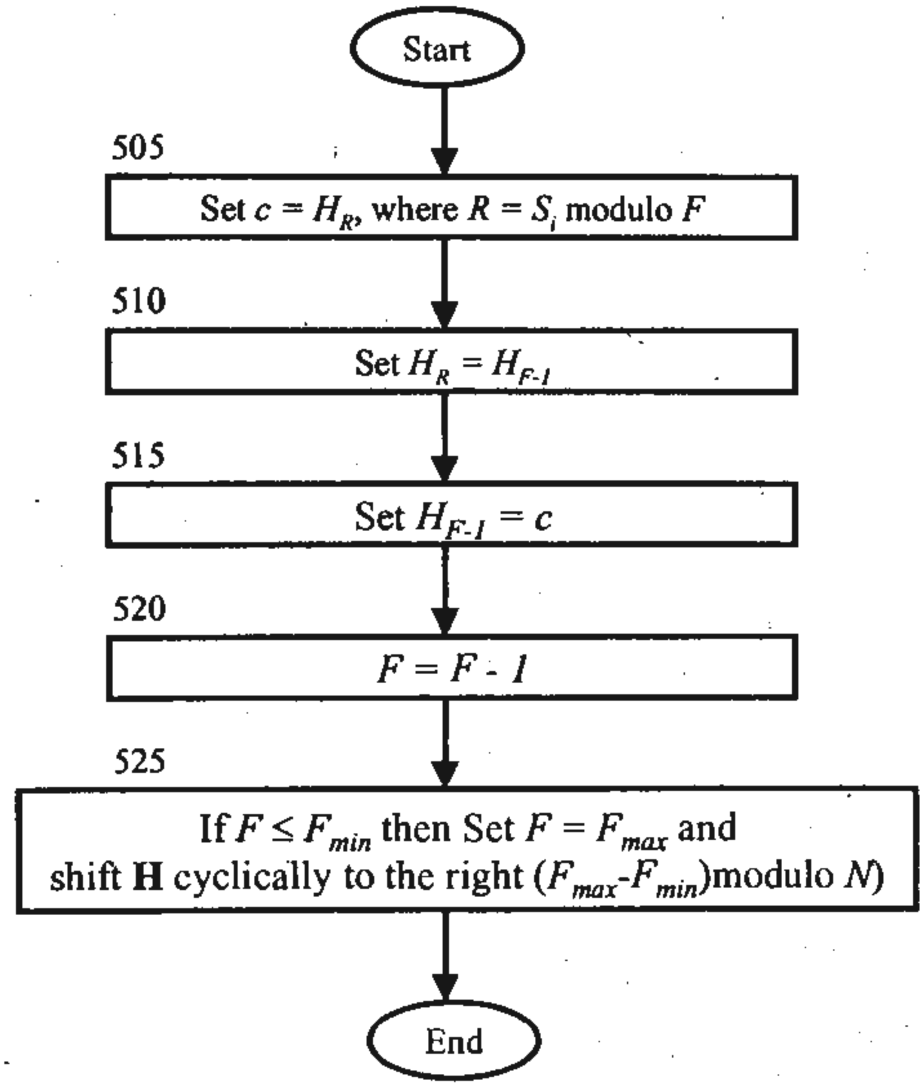
Prior Art

Parameter	Definition	Range
TDMA Frame Number, *FN*	TDMA frame number	0 to (26 x 51 x 2048) - 1
Time parameter, *T1R*	[FN div (26 x 51)] modulo 64	0 to 63
Time parameter, *T2*	FN modulo 26	0 to 25
Time parameter, *T3*	FN modulo 51	0 to 50
Hopping Sequence Number (*HSN*)	Used along with other time parameters to generate a pseudo-random hopping sequence	0 to 63
NBIN	Number of bits required to represent *N*	
xor	Bit-wise exclusive or of 8 bit binary operands	

Table One

APPENDIX E

FIG. 5



APPENDIX F

Balachandran-Kang-Sanwal-Seymour 21-1-3-12

FIG. 6

column 1

row 1

Burst Number	Hopping index	A	Compute Hop Frequency	H	F
--	--	--	--	$H = \{1\ 3\ 4\ 6\ 2\ 0\ 5\ 7\}$	$F = 4$
0	1	$A = \{1\ 3\ 4\ 6\}$	$H_{(1 \bmod 4)} = H_1 = 3$	$H = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 3$
1	5	$A = \{1\ 6\ 4\}$	$H_{(5 \bmod 3)} = H_2 = 4$	$H = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 2$
2	2	$A = \{1\ 6\}$	$H_{(2 \bmod 2)} = H_0 = 1$	$H = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 1$
3	4	$A = \{6\}$	$H_{(4 \bmod 1)} = H_0 = 6$	$H = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$ $H = \{2\ 0\ 5\ 7\ 6\ 1\ 4\ 3\}$	$F = 0,$ $F = 4$
4	1	$A = \{2\ 0\ 5\ 7\}$	$H_{(1 \bmod 4)} = H_1 = 0$	$H = \{2\ 7\ 5\ 0\ 6\ 1\ 4\ 3\}$	$F = 3$
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•

Table Two

APPENDIX G

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

30594 7590 01/13/2006

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. BOX 8910
RESTON, VA 20195

EXAMINER	
ZHENG, EVA Y	
ART UNIT	PAPER NUMBER
2634	

DATE MAILED: 01/13/2006

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/850,124	05/07/2001	Krishna Balachandran	29250-000873/US	1172

TITLE OF INVENTION: ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$1700	04/13/2006

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 07/05) Approved for use through 04/30/2007.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450**

or Fax (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

30594 7590 01/13/2006

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. BOX 8910
RESTON, VA 20195

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/850,124	05/07/2001	Krishna Balachandran	29250-000873/US	1172

TITLE OF INVENTION: ENHANCED FREQUENCY HOPPING IN A WIRELESS SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$1700	04/13/2006

EXAMINER	ART UNIT	CLASS-SUBCLASS
ZHENG, EVA Y	2634	375-130000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 ______

2 ______

3 ______

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

☐ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies ______

4b. Payment of Fee(s):

☐ A check in the amount of the fee(s) is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number ______ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ______ Date ______

Typed or printed name ______ Registration No. ______

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/850,124	05/07/2001	Krishna Balachandran	29250-000873/US	1172

30594 7590 01/13/2006

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. BOX 8910
RESTON, VA 20195

EXAMINER	
ZHENG, EVA Y	
ART UNIT	**PAPER NUMBER**
2634	

DATE MAILED: 01/13/2006

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 842 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 842 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571) 272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

Notice of Allowability	**Application No.** 09/850,124	**Applicant(s)** BALACHANDRAN ET AL.	
	Examiner Eva Yi Zheng	**Art Unit** 2634	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to _RCE filed on 10/14/05_.

2. ☒ The allowed claim(s) is/are _1, 3, 5, 6, 8-10,12-17,19, 21, 22, and 24-26_ .

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

Request for Continued Examination

1. The request filed on Oct 14, 2005, for a Request for Continued Examination (RCE) under 37 CFR 1.114 based on parent Application No. 09/850,124 is acceptable and a RCE has been established. An action on the RCE follows.

Allowable Subject Matter

2. Claims 1, 3, 5, 6, 8-10,12-17,19, 21, 22, and 24-26 are allowed.

3. The following is an examiner's statement of reasons for allowance:

None of the prior art teaches or suggests a frequency hopping method as the current application. In specific, pseudorandomly selecting frequency from a set of N (total number of frequencies available) frequencies, where prior selected frequencies are prohibited from being selected again from the hopping set. Thus, repetition of frequency over time period T is reduced.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eva Y Zheng whose telephone number is 571-272-3049. The examiner can normally be reached on M-F, 7:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Chin can be reached on 571-272-3056. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Eva Yi Zheng
Examiner
Art Unit 2634

December 15, 2005

STEPHEN CHIN
SUPERVISORY PATENT EXAMINE
TECHNOLOGY CENTER 2600